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PLEISTOCENE MAMMALS OF THE YUKON TERRITORY

BY

CHARLES RICHARD HARINGTON

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled PLEISTOCENE MAMMALS OF THE YUKON TERRITORY .... submitted by ....CHARLES RICHARD HARINGTON .... in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Zoology.

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ABSTRACT

This study is based on a selection of specimens from a collection of approximately 14,000 Pleistocene vertebrate fossils made from 1966 to 1975. Most of the ice age mammal material described has come from the Dawson and Old Crow areas in the Yukon Territory. The latter area appears to be the most productive for Pleistocene vertebrate remains in Canada.

Ten orders, 19 families, 44 genera and 64 species of mammals have been identified from Yukon Pleistocene deposits. Among the families, Cricetidae, Mustelidae, Equidae and Bovidae are most strongly represented. Horse, mammoth, bison, caribou, muskrat, ground squirrel, brown lemming and pika remains are the commonest in the collection. Approximately 40% of the species which occupied the Yukon during the ice age are extinct, and about 60% no longer occur in the region.

Early Pleistocene (e.g. plains shrew *(?Planisorex* cf. *dixonensis)*, giant pika *(Ochotona* cf. *whartoni)* and southern mammoth *(Mammuthus* cf. *meridionalis)*); middle Pleistocene (e.g. Soergel's muskox *(Soergelia* cf. *elisabethae)*, Staudinger's muskox *(Praeovibos priscus)*,

giant moose *(Alces latifrons)*, steppe mammoth *(Mammuthus* cf. *armeniacus)*, and large horses *(Equus* cf. *(Plesippus) verae)*); and late Pleistocene (e.g. Yukon wild ass *(Equus (Asinus) lambei)*, moose *(Alces alces)*, tundra muskox *(Ovibos moschatus)*, arctic fox *(Alopex lagopus)*, Dall sheep *(Ovis ?dalli)*, and western bison *(Bison bison occidentalis)*) mammal remains are recognized in the Yukon Pleistocene fauna.

A large number of direct radiocarbon dates indicate that the following species occupied the Eastern Beringian refugium from approximately 30,000 to 10,000 years ago: ground squirrel *(Spermophilus parryi)*, American lion *(Panthera leo atrox)*, woolly mammoth *(Mammuthus primigenius)*, Yukon wild ass *(Equus (Asinus) lambei)*, western camel *(Camelops* sp.), caribou *(Rangifer tarandus)*, large-horned bison *(Bison crassicornis)*, Sargent's muskox *(Boötherium sargenti)*, helmeted muskox *(Symbos cavifrons)* and Dall sheep *(Ovis ?dalli)*. A caribou tibia fleshing tool made by man yielded a radiocarbon date of $27{,}000 \pm {}^{3000}_{2000}$ years B.P.

Two basic components comprise the Yukon ice age mammal fauna. An estimated 75% of the species (mainly cold-adapted) were derived from Eurasia or Beringia, while 25% (mainly dry, scrub grassland species) seem to have been

derived from southern North America. The first group reached the Yukon chiefly by the Bering Isthmus during glacial maxima; the second group entered mainly by the "western corridor" along the eastern margin of the Cordillera.

Analysis of habitat information on 52 of the mammal species represented in the Yukon collection suggest the following preferences: grassland (33%), tundra (20%), forest (17%), parkland (16%), water (11%), alpine (3%).

Detailed studies based largely on fossil pollen, plant macrofossils, molluscs, ostracodes, and vertebrates at sites of ?Sangamon (> 54,000 years B.P.), and mid-Wisconsin (32,400 ± 770 years B.P.) age have provided interesting glimpses into Pleistocene paleoenvironments in the Yukon Territory.

ACKNOWLEDGEMENTS

This study began in 1966 and has been supported since that time by the National Museum of Natural Sciences of the National Museums of Canada. I am grateful to Drs. A.W.F. Banfield and L. Lemieux, successive directors of the National Museum of Natural Sciences, and to Dr. D.A. Russell, Chief of the Paleobiology Division, for continuing support of this long-range project. The Canadian Wildlife Service and the National Museums of Canada provided important aid by allowing me to take academic leave at the University of Alberta in 1963-64 and 1969-70 respectively.

Drs. O.L. Hughes and L.H. Green of the Geological Survey of Canada stimulated my interest in the Yukon as a potential site for collecting ice age vertebrates. Dr. Hughes showed me a number of important sites in the Dawson Area in 1966, and gave me a map showing a few Pleistocene vertebrate localities near Old Crow that he had recorded during "Operation Porcupine". He has made valuable collections of Pleistocene mammals from various parts of the Yukon and has provided stratigraphic information on the most important sites. Dr. A. Lissey of Brock University, then of the Geological Survey of Canada,

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LIST OF ABBREVIATIONS

a	Approximate measurement.
ANSP	Academy of Natural Sciences of Philadelphia.
BCPM	British Columbia Provincial Museum, Victoria.
BM(NH)	British Museum (Natural History), London.
B.P.	Before present (i.e. before 1950).
C	Canine or caniniform tooth, with superscript (upper) and subscript (lower).
CM	Carnegie Museum, Pittsburgh.
cm	Centimeter (used with measurements).
CNHM	Chicago Museum of Natural History, Chicago.
CV	Coefficient of variation.
d	Milk (or deciduous) tooth.
DCMP	Dawson City Museum, Dawson.
e	Estimated measurement.
F:AM	Frick Collection, American Museum of Natural History, New York.
GRPM	Grand Rapids Public Museum, Grand Rapids, Michigan.
GSC	Geological Survey of Canada Radiocarbon Dating Laboratory, Ottawa.
GIN	Geological Institute, USSR Academy of Sciences, Moscow.
GX	Geochron Inc., Boston.
I	Incisor tooth; with subscript (lower) and superscript (upper).

I	Teledyne Isotopes, Westwood, New Jersey.
K	University of Copenhagen radiocarbon dating laboratory, Copenhagen.
km	Kilometer.
L	Lamont Geological Observatory radiocarbon dating laboratory, New York.
LACM	Los Angeles County Museum, Los Angeles.
LAM	See LACM.
LUM	Laurentian University Museum, Sudbury, Ontario.
M	Mean of a series of measurements.
m	Meter (used with measurements).
M	Molar or molariform tooth; with superscript (upper) and subscript (lower).
M	University of Michigan radiocarbon dating laboratory, Ann Arbor.
mm	Millimeter.
MO	University of Moscow radiocarbon dating laboratory, Moscow.
N	Number of specimens in sample.
NMC	National Museums of Canada, Ottawa.
OCR	Old Crow River - specimen collected by party under the direction of W.N. Irving, Department of Anthropology, University of Toronto.
OR	Observed range of measurements of specimens.
P	Premolar tooth; with subscript (lower) and superscript (upper).

PIN	Paleontological Institute, USSR Academy of Sciences, Moscow.
Plus (+)	Measurement smaller than what the original would have been because of wear or damage.
PU	Princeton University, Department of Geological and Geophysical Sciences, New Jersey.
S or SD	Standard deviation.
SE	Standard error.
SEM	Scanning electron microscope.
SI	Smithsonian Institution radiocarbon laboratory, Washington, D.C.
SM	University of Saskatchewan Department of Anthropology, Saskatoon.
ST	Geological Survey of Sweden radiocarbon laboratory, Stockholm.
T	Geochemical and Analytical-Chemical Institute, USSR Academy of Sciences, Moscow.
TSM	Tennessee State Museum.
UA	University of Alaska, College.
UA*	University of Alberta, Edmonton.
UCMP	University of California Museum of Paleontology, Berkeley.
UMMP	University of Michigan Museum of Paleontology, Ann Arbor.
UMMZ	University of Michigan Museum of Zoology, Ann Arbor.
USNM	United States National Museum, Washington, D.C.

W	U.S. Geological Survey radiocarbon laboratory, Washington, D.C.
YPM	Yale University, Peabody Museum of Vertebrate Paleontology, New Haven.
ZIN	Zoological Institute, USSR Academy of Sciences, Leningrad.

Terminology

For purposes of this discussion, where areas are specifically defined in the text and used in a special sense, capitals are applied (e.g. Dawson Area, Old Crow Area, Eastern Beringia). Capital letters are also applied to proper names of birds (e.g. Snowy Owl) and breeds of dogs (e.g. Chow Chow), practises adhered to by the American Ornithologists' Union and the American Kennel Club respectively. For the sake of variety, the term ice age is used here as an alternative to Pleistocene.

INTRODUCTION

During Pleistocene continental glaciations, as ice from the central areas spread over Canada, mammals were forced to shift their ranges until, at the peaks of glaciations, they occupied three or four main survival areas or refugia: (a) the southern refugium in unglaciated parts of the northern United States; (b) the Beringian refugium, in unglaciated areas of the Yukon and Alaska and extending across the Bering Isthmus into eastern Siberia; (c) the Banks Island refugium, which existed at least during the late Pleistocene in the western Canadian Arctic Islands; and (d) the Pearyland refugium in northern Greenland. Of these refugia, the Beringian is one of the most interesting because of its importance as a periodic connecting link between the mammalian faunas of Eurasia and America. Basic information on the history of Beringia, its past environment and the faunal interchange which occurred there is included in "The Bering Land Bridge" (1967).

Throughout the Pleistocene, large, contiguous, unglaciated areas of the Yukon and Alaska (Eastern Beringia) were occupied by relatively rich, homogeneous mammalian faunas, and it is difficult to obtain a satisfactory

perspective on Yukon Pleistocene mammals without considering Alaska. As I (Harington 1970, pp. 35-51; Harington 1976 MS.) have attempted to provide reviews of that nature, this study is confined mainly to the results of my field work in the Dawson and Old Crow areas of the Yukon during the 1966-75 period. Because these two areas contain some of the richest Pleistocene mammal sites in Canada and Beringia, they provide a significant insight into the mammalian history of this interesting part of the world. Studying these faunas is like putting a finger on the Eurasian-American faunal pulse.

No detailed study of Yukon Pleistocene mammals has been undertaken before, and no comparable study on a state-wide basis is available from adjacent Alaska. Because the Yukon is situated on a route of mammal migration between Eurasia and the central regions of North America, it is important from paleontological and zoogeographical view-points to examine the Pleistocene faunal evidence there. Only by studying this kind of evidence can we hope to gain a sound idea of the origins of the present North American mammalian fauna. The object of this study is to answer the following questions: (a) What mammals occupied the Yukon during the ice age? (b) When did they live there? (c) Where did they come from? (d) How did they get there?, and

(e) Under what environmental conditions did they live?

The main part of this report consists of identifying, describing, measuring and comparing ice age mammal remains collected from the Dawson and Old Crow areas. In some cases pertinent specimens in other museums are mentioned, and these data are augmented with information derived from literature research.

Obtaining a satisfactory idea of the geological age of Yukon Pleistocene mammals is a great challenge. Because localities where most of the specimens have been collected were unglaciated, stratigraphic dating of faunal remains is difficult. No thick tills are present to indicate periods of glaciation. But, occasionally, other stratigraphic clues are present that seem to mark peaks of glaciation or glacial periods. In an effort to clarify this problem, I have taken samples of bone from various species, and of associated organic material (wood, mollusc shells, peat), for radiocarbon dating in order to supplement stratigraphic information derived mainly from the work of O.L. Hughes and from personal observation. Of course, radiocarbon dates can only provide an idea of the age of organisms during the last 50,000 years - merely 2.5% of the entire length of the Pleistocene, which is currently estimated to have covered the last 2 million years (Berggren and Van Couvering 1974, p. 164).

An attempt to explain the origins of Yukon ice age mammals hinges on a consideration of their known fossil distribution and their probable dispersal centres, which in turn is based on our present knowledge of their ancestry. Where mammals represented in Yukon Pleistocene deposits are still living, their present distribution and degree of endemism can also yield suggestive evidence of their past distribution. Available migration routes to and from the Yukon during the Pleistocene are limited. Consideration is given to the "western corridor" along the eastern margin of the Rocky Mountains, and the Bering Isthmus, which connected Eurasia and America during periods of world wide sea-level depression at times of glacial maxima. A link between Eastern Beringia and southern North America through the interior of British Columbia is also worth considering (Harington *et al.* 1974, p. 302).

It is important to try to fit ice age mammals into their natural surroundings. This helps to make the study of fossils a lively and interesting subject. Fossils of species with particular adaptations and habitat requirements often suggest the nature of past environments of a locality or region. My basic assumption here, which is open to challenge, is that species represented by fossils had ecological requirements similar to those of the same or closely allied living species. In some cases, other fossils

directly associated with mammal remains have provided clues to habitats of extinct mammalian species. Studies of fossil pollen, plant macrofossils, insect remains, and Pleistocene mollusc shells have shed new light on environments occupied by Yukon ice age mammals.

Brief consideration is given to the presence of man in the Yukon during the late Pleistocene.

From a zoologist's view, many of the following descriptions will be merely tantalizing, for one of the common strictures in working with fossils is their incompleteness. A tooth critical to the identification of a species may be missing from a jaw; or unique characteristics of an articular surface of a humerus may be eroded.

Another common problem is locating adequate Recent mammal specimens with which to compare the fossils. There is no quicker way to discover the weaknesses of zoological collections! The problem is accentuated where relatively rare, extinct genera or species are discovered; in some cases only a few skeletal elements of extinct Pleistocene mammals are known. On the other hand, specimens of some Yukon ice age mammals are remarkably abundant and well preserved (e.g. almost

perfect hornsheaths of *Bison crassicornis* from frozen muck deposits near Dawson). Such limitations should be borne in mind when reading this report.

I feel that the fossil collections made since 1966 are sufficient to ensure that most of the large mammals living in unglaciated parts of the Yukon during the late Pleistocene have been sampled. Still, it would be valuable to have better specimens of some species, and enough specimens of certain kinds to permit statistical treatment. These deficiencies are an incentive for carrying out further field work. Probably some surprises still remain with regard to the microvertebrates. Matrix has been screened at a few suitable localities in the Old Crow Area during the field seasons of 1971 and 1973, but this method has yet to be applied at sites in the Dawson Area. I hope to do this soon. It will take a few years to satisfactorily describe the thousands of microvertebrate remains (including fish and bird fossils) screened from sediment at Old Crow localities 27W and 44.

Another problem that strictly limits knowledge about the geological age and environments of Yukon ice age animals is the fact that relatively complete specimens, in their original position at death, are seldom found. Indeed, most bones from Old Crow and Dawson localities show signs of

having been reworked at least once or twice. This re-cycling of fossil deposits can result in mixing, so it is often difficult to tell whether all species identified from a single stratigraphic unit lived in the same area at the same time. It is best to retain a healthy skepticism in this regard. Careful taphonomic studies may help to overcome such problems in the future.

DESCRIPTION OF THE STUDY AREAS

Yukon Territory

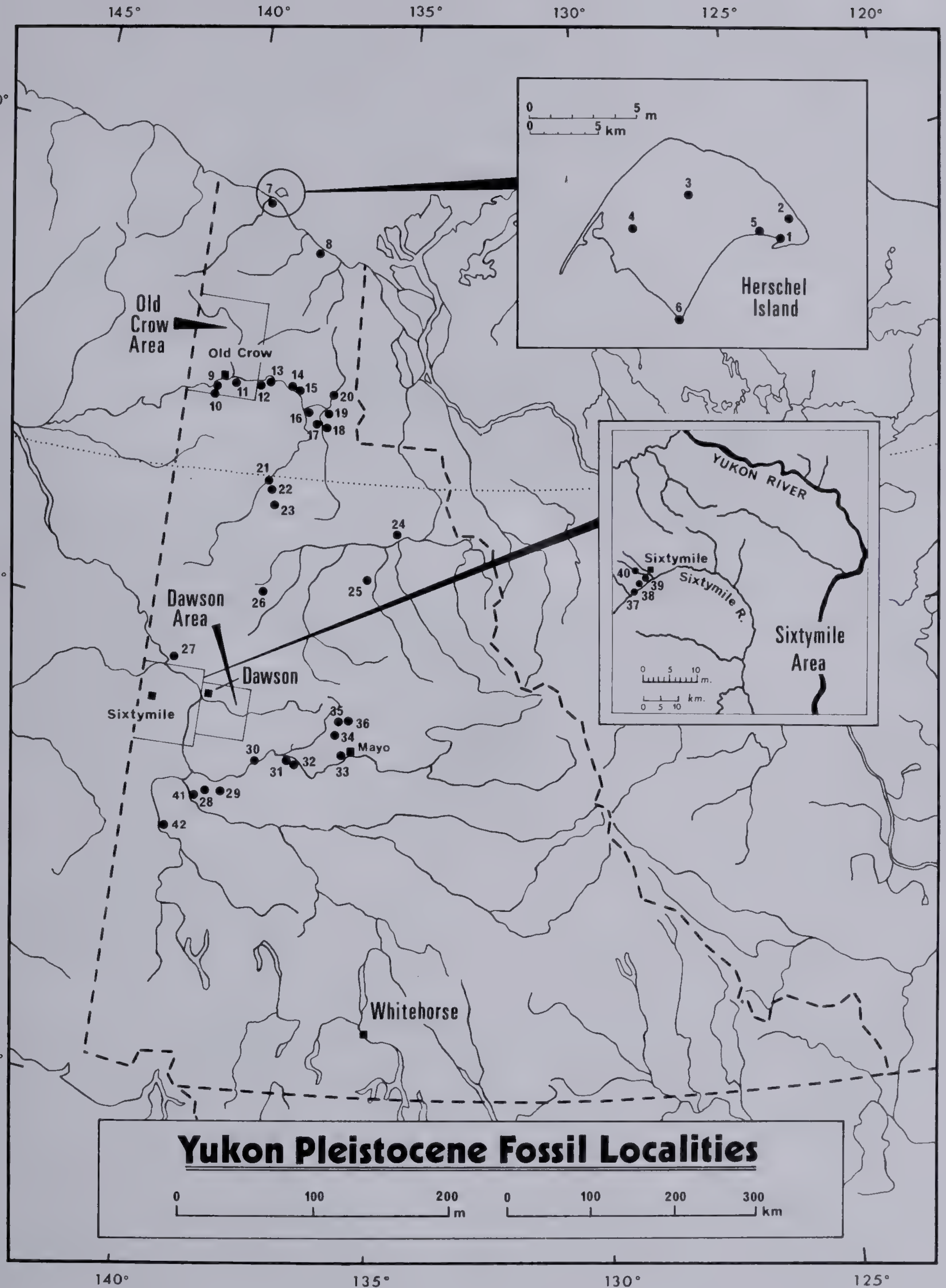
Situated in a right-angled triangular area forming the northwest corner of Canada, the Yukon lies north of 60° and extends westward from near the eastern margin of the Canadian Cordillera to the 141st meridian, where it borders on Alaska. The Yukon covers 536,327 km^2 - larger than all the New England states and more than twice the size of Great Britain. The physical features of the landscape have been described by Bostock (1948).

The area has a colorful history. Twice it has exceeded its present population of just under 20,000: in 1898 during the Klondike gold rush the population of Dawson City reached nearly 30,000; and again 46 years later White-horse reached nearly 40,000 during the Second World War

FIGURE 1. PLEISTOCENE VERTEBRATE LOCALITIES IN THE YUKON TERRITORY.

LEGEND:

MAP NUMBER	LOCALITY NUMBER	MAP NUMBER	LOCALITY NUMBER
1	Herschel Island Loc. 1	22	Whitestone River Loc. 43
2	Herschel Island Loc. 2	23	Whitestone River Loc. 1
3	Herschel Island Loc. 3	24	Peel Plateau Loc. 1
4	Herschel Island Loc. 4	25	Hungry Creek Loc. 1
5	Herschel Island Loc. 5	26	Ogilvie River Loc. 1
6	Herschel Island Loc. 6	27	Cliff Creek Loc. 1
7	Arctic coast Loc. 1	28	Brewer Creek Loc. 1
8	Arctic coast Loc. 2	29	Scroggie Creek Loc. 1
9	Porcupine River Loc. 100	30	Stewart River Loc. 1
10	Bluefish River Loc. 1	31	Stewart River Loc. 2
11	Porcupine River Loc. 1	32	Stewart River Loc. 3
12	Porcupine River Loc. 34	33	Stewart River Loc. 4
13	Porcupine River Loc. 2	34	Highet Creek Loc. 1
14	Porcupine River Loc. 3	35	Haggart Creek Loc. 1
15	Porcupine River Loc. 40	36	Dublin Gulch Loc. 1
16	Porcupine River Loc. 35	37	Sixtymile Area Loc. 1
17	Eagle River Loc. 37	38	Sixtymile Area Loc. 2
18	Eagle River Loc. 38	39	Sixtymile Area Loc. 3
19	Rock River Loc. 1	40	Sixtymile Area Loc. 4
20	Bell River Loc. 1	41	Thistle Creek Loc. 1
21	Porcupine River Loc. 4	42	White River Loc. 1


Yukon Pleistocene Fossil Localities
Old Crow Area
Old Crow
Dawson Area
Dawson
Sixtymile
Mayo
Whitehorse
Herschel Island
Sixtymile Area
YUKON RIVER
Sixtymile R.
145°
140°
135°
130°
125°
120°
70°
65°
60°
0 100 200 m
0 100 200 300 km

when the Alaska Highway was constructed. In 1953 the territorial capital was moved from Dawson to Whitehorse, which has become a major transportation centre in the northwest part of the continent.

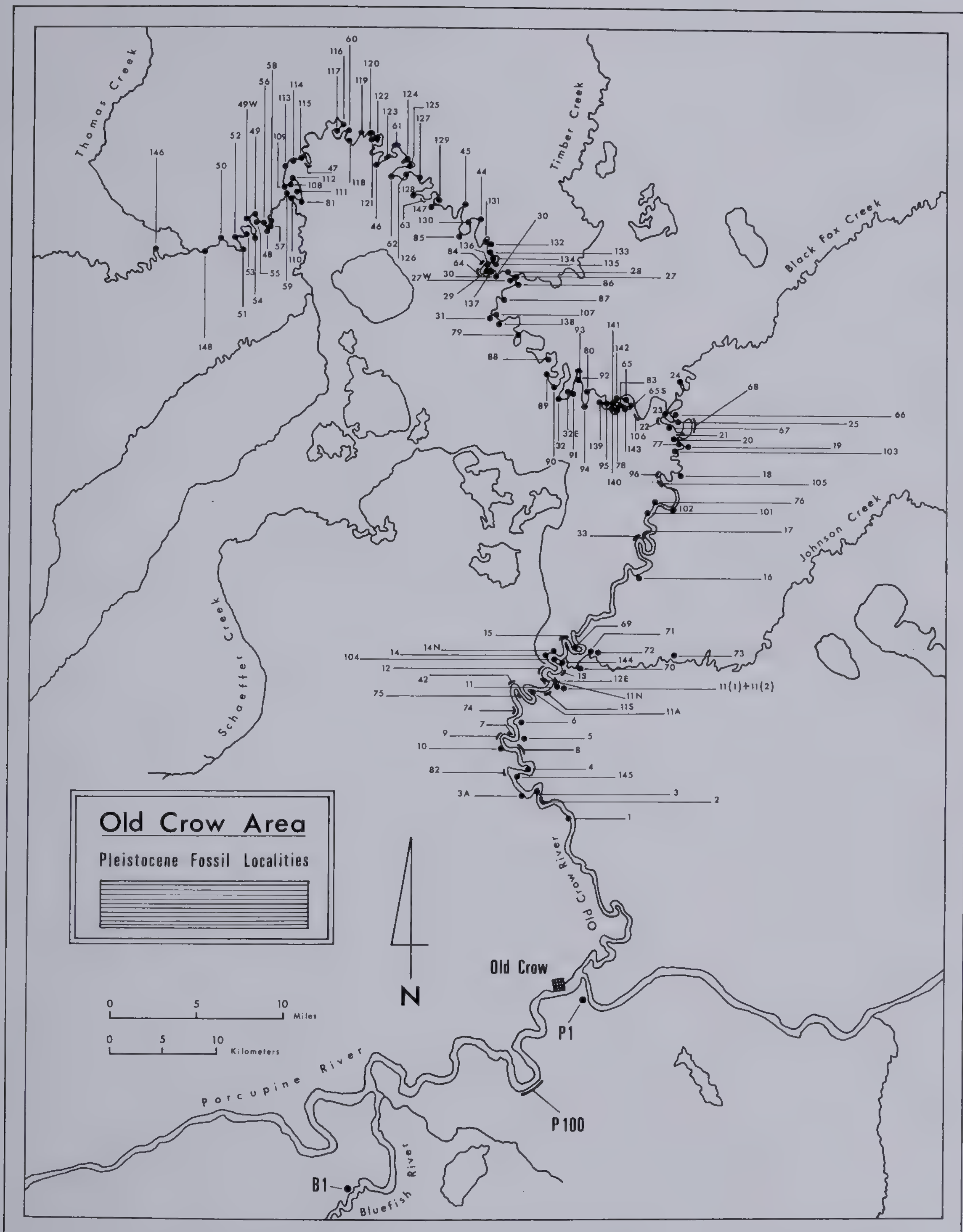
This study concentrates on two districts in the unglaciated western part of the Yukon, the Old Crow and Dawson areas, both of which are highly productive of ice age mammal remains. Fossil deposits at Old Crow are exposed by stream erosion, which is most effective during the spring melt period. In contrast, Dawson fossil beds are generally exposed by artificial means (e.g. monitoring with high pressure jets of water, washing with dammed up water behind automatic gates, and dredging) in the course of man's search for gold. Occasionally specimens from other localities will be mentioned in this study (Figure 1).

Old Crow Area

The Old Crow Basin ("Old Crow Plain" of Bostock (1948, p. 76)) covers an area of approximately 6,216 km^2 centred on about 68°N, 140°W (Figure 2) (Lawrence 1973, p. 307). During Devonian time the area was part of an orogenic belt extending into the northern Brooks Range of Alaska. Conglomerates such as those exposed on Dave Lord

FIGURE 2. PLEISTOCENE VERTEBRATE LOCALITIES IN THE OLD CROW AREA.

Numbers on the map are those of the actual fossil localities.


Old Crow Area
Pleistocene Fossil Localities
0 5 10 Miles
0 5 10 Kilometers
N
Thomas Creek
Timber Creek
Black Fox Creek
Johnson Creek
Schaeffer Creek
Old Crow River
Old Crow
P1
P100
Porcupine River
Bluefish River
B1

Ridge were then deposited on the east side of the basin. Quieter conditions prevailed during the Mississippian when the Kayak Shale and open marine crinoidal limestone of the Lisbourne Group were deposited. Apparently pre-Permian uplift and erosion removed the Mississippian rock from much of the southern part of the area. Permian conglomerate rests with angular conformity on Silurian graptolitic shale on the eastern margin of the Old Crow Basin (Norford 1964). Little or no sediment seems to have been deposited in the area during the Triassic, but a major marine transgression, starting in Middle Jurassic time, deposited Jurassic and Cretaceous sediment over the whole area (Jeletzky 1975).

The Old Crow Basin as it exists now was formed by downwarping and/or faulting during the Laramide orogeny in Tertiary time with subsequent infilling of late Tertiary to Recent clastics. The latter nonmarine sediments blanket the basin to a depth of from 460 to 610 m (Lawrence 1973, p. 311). The depth of the Pleistocene deposits is unknown. Probably it would be necessary to take a core from the central part of the basin in order to answer this question. Stratigraphic sections measured at some of the highest bluffs along the Old Crow River indicate that ice age sediments reach depths of over 37 m.

Commonly exposed at the bottom of the thickest Pleistocene sections is a basal clay unit ("Older deltaic, lacustrine and fluvial sediments" of Hughes (Lichti-Federovich 1973, Figure 2)) characterized by a rolling, evidently heavily eroded surface with peaty mats in some of the depressions. At some places this irregular surface may be attributed to thawing of permafrost, and thus may be an expression of Pleistocene thermokarst (see Brown and Kupsch 1974, p. 41). At many exposures the basal clay is overlain by a gray sandy silt to fine gravel containing abundant fossils. A very thick layer of deltaic and lacustrine silts (= "Deltaic and lacustrine sediments (silt with minor fluvial sand and gravel)" of Hughes (Lichti-Federovich 1973, Figure 2)) cover the fossil-bearing unit, which is in turn overlain by an upper glaciolacustrine unit and silt and peat of postglacial age. Although Hughes (Lichti-Federovich 1973, p. 563) suggested that this section ranges in age from early Wisconsin to postglacial, more recent evidence, which I will mention later, indicates that the basal clay unit is older - perhaps of Illinoian age.

The Old Crow Area lies within the continuous permafrost zone (Brown, 1970), and occasionally in summer the contents of large basins of melted muck from the upper glaciolacustrine unit surge down into the Old Crow River.

In a few cases these solifluction lobes, carrying trees and shrubs from the surface, partially block the river.

Ancient beaches preserved in places along the margins of the basin demonstrate the area and depth of a late Wisconsin lake which occupied it (Hughes 1969, p. 211). About 11,000 years ago a bedrock threshold was breached and the lake began to drain via the Yukon system to Bering Strait. As the Old Crow River cut through the lake bottom sediments, the basin took on its present appearance. Hughes (1969, p. 211) summarized the Pleistocene geological history of the region with particular relation to the movements of Laurentide ice to and from the flanks of the Richardson Mountains to the east. There is no evidence that the Old Crow Basin was ever glaciated. Lichti-Federovich (1973) has reconstructed the late Pleistocene botanical history of the area from samples of fossil pollen taken at six sites within the basin, and has given a tentative interpretation of climate during that period.

Pleistocene mammal fossils are found in various situations: (a) on the surface of river banks, where they have been deposited after high water of the spring melt has subsided. In this case they may have slid down the bank with sediment from fossil-bearing units above, or they may

have been washed downstream from other fossil localities; (b) on modern point bars; (c) in sands and gravels of terraces which have been laid down during the last few thousand years. Generally the ice age mammal fossils have been reworked and are much older than the terrace deposits; (d) in buried point bars, which may vary in age from about 10,000 to a few thousand years ago. Again, the fossils are usually older than the deposits in which they are found; and (e) in place at various levels in the high bluffs cut by the river. Fossils from organic sediments in place near the surface of, and directly overlying the basal clay were deposited over 54,000 years ago, while the youngest Pleistocene mammal fossils found in place near the upper surface of the bluffs are about 12,000 years old. Fossils of the extinct muskoxen *Soergelia* and *Praeovibos* and the giant moose *Alces latifrons* suggest that deposits as old as middle Pleistocene age may be exposed within the basin - perhaps where tributaries of the Old Crow River such as Johnson and Black Fox creeks cut down to Tertiary rock near the eastern margin of the basin. Traces of early Pleistocene mammals are present also.

At present, the Old Crow Basin is circled by hills and low mountains: the British Mountains to the north; the Richardson Mountains to the east; and the Porcupine Plateau

and Old Crow Range to the south. Much of the basin lies at an elevation of 380 m above sea-level. It is dominated by a few bedrock outcrops such as Schaeffer Mountain and Timber Hill, the former rising to over 610 m above sea-level. Nearly half of the basin is covered by shallow lakes, ponds and sluggish streams. Patches of tundra occur on the floor of the basin, whereas spruce, willow and alder dominate the lower levels along the banks and meander scars of the Old Crow River and its tributaries. Lichti-Federovich (1973, pp. 554-557) gives more details on the vegetation. A description of the terrain in the southern part of the basin has been compiled by Monroe (1974).

Total annual precipitation in the Old Crow Basin is 25 cm, of which half falls as snow. The growing season is about 80 days, with 1000 degree-days above 42°F (6.7°C). The mean daily July temperature is 50°F (10°C) (Lichti-Federovich 1973, p. 554).

Dawson Area

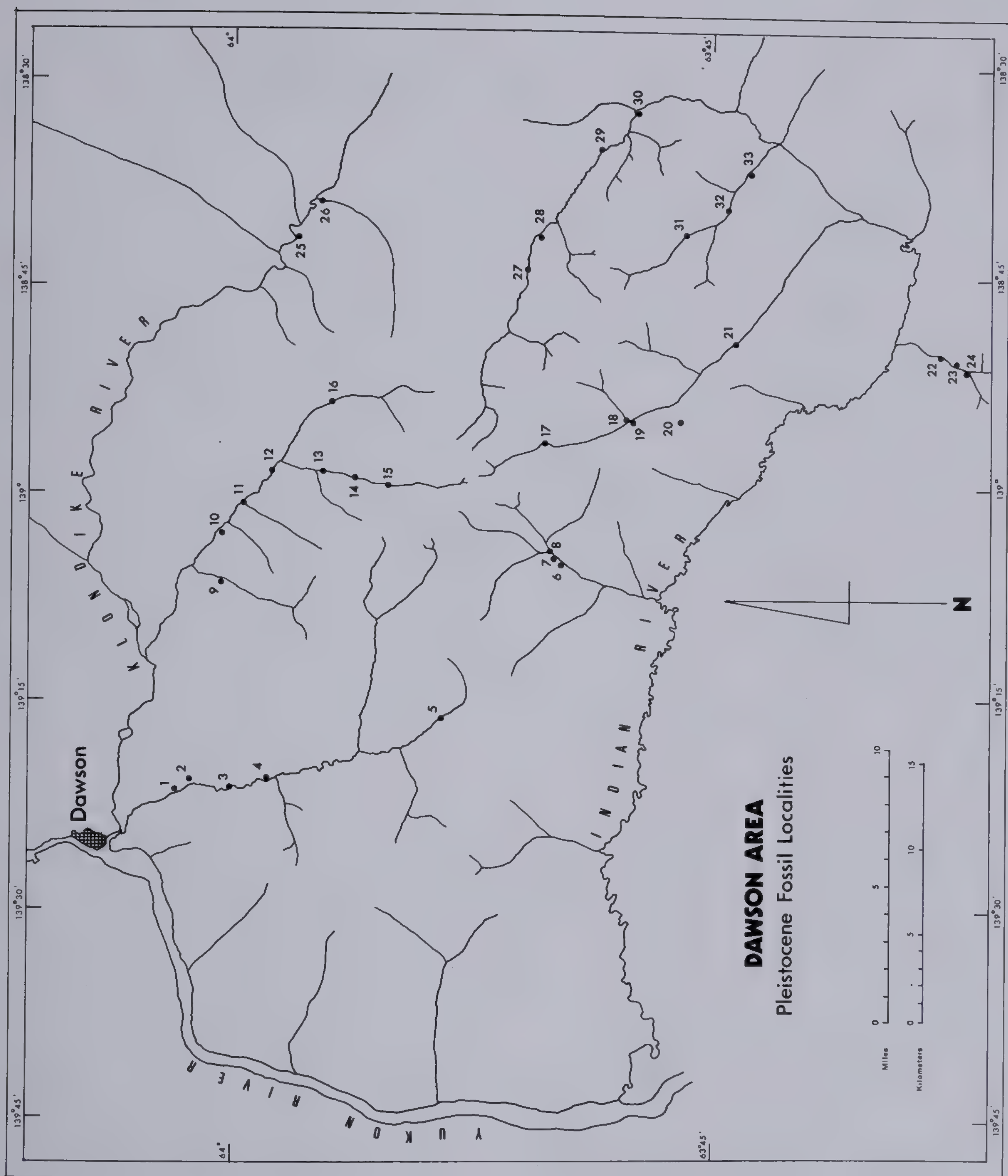
This area consists of approximately 2,590 km^2 centred on about 63°50′ N, 139°00′ W (Figure 3). It includes the principle gold-bearing creeks and is equivalent to the "Klondike Region" or "Klondike Gold District"

FIGURE 3. PLEISTOCENE VERTEBRATE LOCALITIES IN THE DAWSON AREA.

LEGEND:

Numbers on the map are those of the actual fossil localities. Names in brackets are of placer miners who hold, or who have held, claims on which vertebrate fossils have been discovered.

1 - Bonanza Creek, Trail Hill (Nicolson).
2 - Bonanza Creek, Cripple Hill (Heitman).
3 - Bonanza Creek, claim 52 below discovery.
4 - Bonanza Creek, claim 37.
5 - Eldorado Creek (Franklin, Caley).
6 - Quartz Creek (Schmidt).
7 - Quartz Creek (Sailer).
8 - Quartz Creek (Rasmussen, Lacross).
9 - Last Chance Creek, Discovery Pup.
10 - Hunker Creek, 80 Pup (Kosuta).
11 - Hunker and Independence Creeks - juncture.
12 - Hunker Creek (Fant, Norback).
13 - Gold Bottom Creek (Lunde).
14 - Gold Bottom Creek.
15 - Gold Bottom Creek (Bratsberg).
16 - Hunker Creek (Erickson, Leidtke).
17 - Sulphur Creek (Djukastein).
18 - Sulphur Creek, Friday Gulch (Gibson).
19 - Sulphur Creek.
20 - Sulphur Creek area.
21 - Sulphur Creek, claim 50 below discovery.
22 - Eureka Creek (Haakonson).
23 - Eureka Creek (Ross).
24 - Eureka Creek (Cole Brothers).
25 - Flat Creek, bench (Strachan).
26 - All Gold Creek (Kinakin).
27 - Dominion Creek, just below lower discovery.
28 - Dominion Creek (Schmidt).
29 - Dominion Creek (Sailer).
30 - Dominion Creek (Burgelman).
31 - Gold Run Creek, claim 57a.
32 - Gold Run Creek (Schink, Lamontagne).
33 - Gold Run Creek (Ross, Matson).



DAWSON AREA
Pleistocene Fossil Localities

as defined by McConnell and Tyrrell (1898). It is situated between the Klondike and Indian rivers and is east of the Yukon River. McConnell (1903, 1905) and Bostock (1943) have reported on the geology of the area.

The region is underlaid by a complex of rock formations that range in age through the greater part of the geological scale and that are highly varied in structure and composition. The area has been repeatedly broken through by igneous intrusions and has been subjected to great pressure resulting from earth movements. For example, massive igneous rocks have been sheared, granulated and crushed into finely plicated schists, and in many cases the clastic rocks have been recrystallized to resemble igneous rocks.

The oldest rocks are thick schists of Precambrian age, which Bostock calls the Yukon Group. They form the foundation of the Dawson Area and are exposed along Hunker and Dominion creeks. Apparently they have been downwarped to form a major north-northwest trending syncline that crosses the Indian River just above its mouth. The Yukon Group is intruded by Paleozoic? Klondike Schist, which consists of mica, chlorite, and amphibolite schists, and which underlies most of the area (Geol. Surv. Can. Map

1048A, 1957). Although gold-bearing quartz veins penetrating the Klondike Schist are generally of low value, McConnell (1905) and Tyrrell (1912) indicate that they are rich enough to account for the placer deposits in the Klondike creeks. Basic and ultrabasic intrusive rocks, mainly of Mesozoic age, are exposed northwest of Allgold Creek and near the juncture of Montana Creek with Indian River. Acidic intrusives (Coast Intrusions) of similar age occur north of the mouth of Indian River.

At present, the Dawson Area is a maturely dissected plateau. King Solomon Dome (1230 m above sea-level) dominates the area. Its summit appears to be the remnant of an early stage of erosion (Campbell 1952, p. 51). It is the principal drainage centre of the district: from it Allgold and Dominion creeks flow eastward, Quartz and Sulphur creeks flow southward, and Gold Bottom and Hunker creeks flow northward.

A remarkable feature of the area is that the topographic surface below the level of King Solomon Dome has been deeply eroded to form broad, high level valleys, which in turn are cut by younger, steeper valleys 60 to 90 m deep. Before these inner valleys were cut, stream gravels were deposited in the broad, high valleys over a long

period of time. These gravels (White Channel gravels) are over 107 m thick near Dawson. They consist of white quartz and pale, leached quartz-muscovite-chlorite schist and are strikingly exposed along Bonanza and Hunker creeks.

Dominion and Sulphur creeks, which flow southward into Indian River, unlike Bonanza and Hunker creeks on the opposite slope, lack high-level terraces. However, Dominion Creek has low terraces along its upper valley. The lower parts of the valleys contain thick gravels of White Channel type overlain by stream gravel of quartzite schist and quartz - resembling those in the beds and low terraces of all streams in the area. At the mouths of Hunker and Bonanza creeks, the White Channel gravels are overlain by Klondike gravels (McConnell 1905) to a depth of about 30 m. The Klondike gravels consist of quartzite, slate, chert, granite and diabase pebbles, largely derived from the western slopes of the Ogilvie Mountains.

Narrow rock terraces, which have a significant bearing on the history of the landscape, occur at various points on the flanks of the steep slopes of the present valleys. They occur at all elevations up to the bottoms of the old valleys, and carry gravel beds from 2 to 5 m thick, which are very similar to those in the creek bottoms.

The terrace gravels, like the creek gravels, are usually overlaid by muck (frozen silt generally consisting of loess or reworked loess with some organic matter). At one point on Hunker Creek, terrace gravels were buried beneath 30 m of muck.

McConnell (1907, p. 6) thought the terrace systems in the Dawson Area were caused by an episode of depression followed by one of uplift. Hughes and Rampton (1972, pp. 33-34) offer an interesting alternative explanation that involves uplift and drainage changes related to glaciation. I will try to summarize their views in the following paragraph.

A broad upwarping on a west-southwest axis crossing the Yukon River between Fortymile River and the Alaskan border was followed by aggradation of the Yukon River as a result of its reduced gradient. Other tributaries including Hunker and Bonanza creeks responded similarly, but south-flowing creeks, such as Dominion and Sulphur, increased in gradient, initiating some cutting near their heads and forming low bedrock terraces. Deposition occurred in the lower parts of these creeks because the Indian River into which they flowed was aggrading. Near the end of the aggradation cycle during the first glaciation in the region,

mountain glaciers advancing down the North Klondike, South Klondike and lesser valleys diverted the Klondike River from the Tintina Trench to its present course, causing deposition there of Klondike gravels and Flat Creek beds. In the Dawson Area, deposition of the White Channel gravels, considered by McConnell to have been laid down in a climate warmer than the present, gave way to gravel evidently produced by weathering in a periglacial environment. Thus, although McConnell thought the White Channel gravels were at least as old as Pliocene, the uppermost part is considered to be earliest Pleistocene. Following this glacial episode, the Yukon River cut nearly to its present grade; the Klondike River was entrenched through the thick fill of Klondike gravels into bedrock and the glacial fill of the Tintina Trench. The lower part of the Indian River cut to the present grade of the Yukon River, but cutting has not extended to Sulphur and Dominion creeks, hence high level terraces are lacking on those streams. Although ice approached within about 32 km of the Dawson Area, like the Old Crow Area, it was never glaciated.

The gravels flooring the creeks and the gullies or "pups" that feed them are generally less than 3 m thick. They are of local origin and are composed of schists with quartz pebbles and boulders, and occasionally with regional

volcanics. The pebbles are commonly embedded in an oxidized sand matrix and alternate locally with thin beds of sand and muck (McConnell 1905).

Muck was the last sediment of any importance to be deposited in the Dawson Area. Although McConnell (1905) records plant remains and Pleistocene mammal fossils enclosed in the creek gravels, I find that they are usually located near the surface of creek, pup or terrace gravels and at the base of the overlying muck. Obalski (1904, p. 216) supports this view: "C'est, en général, à l'intersection mal définie, que j'ai constaté les gisements de fossiles." Occasionally, I have seen Pleistocene mammal bones a few metres up from the base of the muck (e.g. bison bone at Heitman's former claim on Cripple Hill (Dawson Locality 2), and mammoth bone at Kosuta's claim on lower Hunker Creek (Dawson Locality 10)).

Pending further evidence, I suggest that muck deposition resulted from rapid erosion of steppe-like grasslands which evidently existed in the uplands of the region during the late Pleistocene. Perhaps most of the Pleistocene mammal remains were partly washed down and partly moved downslope by mass wastage with abundant loess and vegetation from the former grassland. This phase of

exceedingly heavy, rapid erosion may have taken place about 11,000 years ago. Perhaps most bones were deposited near the surface of local creek gravels and the base of the overlying muck because of their relative density (Harington and Clulow 1973, p. 743). Evidently the transported organic loess was refrozen after this depositional phase, which may be significant as an indicator of rapid climatic change about this time. A publication by Péwé (1975 b, p. 15) tends to support these conclusions. He states that the Goldstream Formation in the Fairbanks region, which I consider to be the equivalent of most of the muck deposits producing mammal remains of late Wisconsin age near Dawson, is a valley-bottom deposit into which vertebrate bones were gradually transported downslope. He then remarks that the Goldstream Formation froze soon after deposition. In addition, it is worth noting that McCulloch and Hopkins (1966, p. 1089) have detected in northwestern Alaska a warm interval approximately spanning the 10,000 - 8,300 years B.P. period, followed by a cold period marked by the Anivik Lake glacial readvance. Therefore, the period during which the muck was refrozen may have been between 8,300 and the hypsithermal, which lasted from about 6,000 to 3,000 years ago in central Alaska. Evidently ice wedges began to grow again in northwestern Alaska about this time (McCulloch and Hopkins 1966, p. 1105).

Since most Pleistocene vertebrate fossils found in the Dawson Area have been exposed and collected as a result of placer mining, a brief description of a common method using a bulldozer and monitor seems pertinent. Usually land is stripped of vegetation by a bulldozer a year or more ahead of time to allow deep melting of the surface muck. Then the partly frozen muck face is washed back by a high pressure jet of water from a large hose or monitor, which is usually fed from a dammed up head of water nearby. Thus, the gold-bearing gravels beneath the muck are exposed and can be pushed by a bulldozer into a sluice box (which lies on a slope below the cut and collects the heaviest minerals, including gold, in the bottom), allowing water to wash the gravel through. Gold is then collected from the matting in the bottom of the sluice box and concentrated. Bulldozing is carried down to a few feet below the weathered bedrock surface, which underlies the gravels, in order to pick up gold that may have sunk into cracks. McConnell (1905) and Campbell (1952, pp. 6-8) give more details on methods of placer mining.

It is during the monitoring phase of the operation that ice age mammal bones are most often exposed at the base of the muck. Many good specimens break up under the impact of water from the monitor, but, fortunately for vertebrate

paleontologists and paleobotanists, some miners pick up and preserve interesting looking specimens.

Paleobotany of the Dawson Area was first studied by Campbell (1952, pp. 106; 108-110), who noted that a Pliocene flora found there indicated a distinctly warmer climate than did a pollen diagram of the Independence Peat Bed, a deposit which evidently developed during hypsithermal time. In 1961, Terasmae (1967, p. 4) examined plant-bearing deposits in the Dawson Area.

At present, trees in the area consist of white and black spruce, aspen and balsam poplar, and white birch. The lower ridges and slopes of the higher ones are generally wooded. Stunted spruce occurs sparingly on the highest points. The flat valleys have patches of spruce and poplar that alternate with bare swamps and marshes. Vegetation on well-drained, south-facing slopes having a deep active layer contrasts greatly with that on lower north-facing slopes (Hughes and Rampton 1972, pp. 34, 36).

Total annual precipitation in the Dawson Area is about 33 cm of which about half falls as snow. The growing season is about 150 days, with 1500 degree-days above $42^{\circ}F$ ($6.7^{\circ}C$). The mean daily July temperature is $56^{\circ}F$ ($14^{\circ}C$) (Atlas of Canada 1974, p. 58).

PREVIOUS WORK

Old Crow Area

The first recorded ice age mammal remains from this part of the Yukon were collected along the Porcupine River prior to 1873 by the Anglican missionary Rev. Robert McDonald (Table 1). Exact localities were not specified for these fossils, only "Upper Porcupine River", so it is conceivable that some or all could have come from the Old Crow River, a tributary of the Porcupine (Maddren 1907, p. 17). Lydekker (1885, pp. 25-27; 1886, pp. 39, 203) mentioned McDonald's specimens in his "Catalogue of the Fossil Mammalia in the British Museum (National History)". Unfortunately, a clue to the relatively early age of some Pleistocene deposits in this area was lost because a muskox cranial fragment belonging to *Praeovibos*, which had not previously been reported from North America, was identified as belonging to the living muskox *Ovibos*. Adams (1881, p. 117) mentioned three mammoth molars from this collection in his work on British fossil elephants.

Four Americans collected fossils along the Old Crow River. A.G. Maddren (1907, p. 9), working for the Smithsonian Institution, in June 1904 heard from Indians of a promising fossil locality on Old Crow River. Maddren decided to explore

Table 1. Pleistocene mammal specimens from the "Upper Porcupine River", Y.T. presented to the British Museum (Natural History) by Rev. Robert McDonald in 1873 (Lydekker 1885, 1886).

SPECIES	SPECIMEN
Bison sp. - bison	Cranial fragment with right horncore (BM(NH) 44063).
	Two mandible fragments (BM(NH) 44064-5).
	Left matacarpal (BM(NH) 44069).
	Damaged dorsal vertebra (BM(NH) 44068).
	Three parts of the vertebral column (BM(NH) 44068-8a).
Mammuthus primigenius (= *"Elephas primigenius"*) - woolly mammoth	Left Molar (LM_3) (BM(NH) 44060.
	Heavily worn right molar (RM_3) with a very narrow crown (BM(NH) 44061).
Praeovibos priscus - (incorrectly identified as *"Ovibos moschatus"*) - Staudinger's muskox	Posterior part of cranium with partial horncores (BM(NH) 44070.

the river, having received assurances that fossil bones there far exceeded those at any other locality known to Indians of the region. He started up the Porcupine River from Fort Yukon on June 23, and explored the lower part of the Old Crow River by following its winding route for some 270 km. Ice age mammal bones were found on the river bars toward the central part of the basin, and Maddren assumed that they were deposited during spring floods by floating ice from the headwaters of the river. About a mile above the first tributary entering the river from the left, a badly damaged mammoth skull was found. A short food supply caused Maddren to turn back on July 23. He (1907, p. 6) stated: "It was with much reluctance we did so for nearly every mile of the last hundred travelled on the Old Crow River had yielded increasing evidence, in the shape of a tooth, a horn core, or a bone lying on the banks below highwater mark, of the existence of deposits containing considerable remains of the skeleton of large Pleistocene mammals". He concluded that extensive Pleistocene mammal remains, representing principally mammoth, bison and horse, existed on the headwaters of the Old Crow River.

While collecting Recent mammals for the Smithsonian Institution during the summer of 1912, Copely Amory, Jr. obtained a small collection of Pleistocene mammal bones from a locality about 80 km from the mouth of the Old Crow River. Of greatest significance was the presence of a camel toe bone,

which Gidley (1913, p. 2) thought was similar in size, but flatter than toe bones of *Camelops*. He considered that the specimen supported the supposition that "milder climatic conditions prevailed in Alaska during probably the greater part of the Pleistocene period", which was rather a broad assumption on the basis of the facts available. Other specimens in the collection were isolated foot bones and teeth of the woolly mammoth, horse, and bison. Gidley remarked on the color and degree of fossilization of the bones, which he thought pretty definitely determined their age as Pleistocene. They were transferred as a gift to the Smithsonian Institution (Gilmore 1941).

O.J. Murie (Geist 1956, pp. 12-13), a United States Biological Survey biologist, made an interesting collection of Pleistocene mammal bones while banding birds in the Old Crow Area in 1926. Most represented horse, mammoth and bison, but a fragment of incisor enamel was identified as belonging to the giant beaver *(Castoroides)*. It was the latter specimen that Murie sent to Otto Geist, which stimulated Geist's interest in the Old Crow Basin as a potential Pleistocene mammal collecting site.

Geist's (1956, p. 13) previous collecting in Alaska for the American Museum of Natural History and the University of Alaska sponsored by Childs Frick had not permitted

extensive work elsewhere. However, sponsored by the University of Alaska and financed by the Explorers Club Exploration Fund, he began his boat trip up the Old Crow River on August 3, 1952 (Dodge and Korff 1953, p. 11; Geist 1955, p. 1702). Peter Lord and Charlie Linklater from the settlement of Old Crow acted as his guides.

By August 5, after passing Schaeffer and Johnson creeks, Geist had begun to collect a few fossils on some of the exposed gravel bars. On August 8, beyond Timber Creek, fossils were found on many sand and gravel bars, and some fossils (mainly mammoth) were found "in place in the hard bases of some of the high cliffs." Geist (1956, p. 16) observed what I have called the basal clay unit: "These lower 8 to 10 feet of the river bank consist of hard, tough, gumbolike material which becomes somewhat brittle when exposed to and baked by the sun." Horse and mammoth specimens were most common along this stretch of the river, but some beaver fossils were collected. Above "Last Cutbank" (Locality 51), the water became clearer and Geist stated: "We could see the fossils on the river bottom as we travelled along. We collected only the valuable ones, mostly mammoth teeth." Fossils were evidently scarce or lacking beyond this point.

On August 21 the party climbed Ammerman Mountain,

which is just west of the Yukon-Alaska border. After they started downstream, the Old Crow River began to drop noticeably and the weather became colder. They usually found fossils when they stopped to rest. Geist walked up Thomas Creek for a few miles and collected some fossils.

Above Timber Creek fossils were collected on bars and at the foot of bluffs. Geist (1956, p. 27) states. "We also dug out a cottonwood (poplar) stump which evidently had been cut down by beavers; and from the width of the tooth marks, it could have been cut down by a giant beaver. This stump we found still buried very near the line which separated the harder lowerpart (basal clay unit) of the high bluff from the soft overlaying mass". The stump measured 28 cm high by 30 cm in diameter. I think this stump is from the gray organic silty sand (Unit 2) at Locality 44, which may be of Sangamon interglacial age, because Geist (1956, pp. 53-54) mentions collecting samples of fossil wood from "silt banks near Jack Frost's trapping camp [=Locality 44]". Charlie Linklater (personal communication 1975) confirms this notion. Fossils were collected near the mouth of Black Fox Creek on August 28, and many specimens, mainly mammoth, were found on rocky bars farther south. They returned to the settlement of Old Crow on August 30, where the fossils were cleaned, shellacked and packed for shipment.

Although Geist was not an expert in scientific identification of Pleistocene mammals, he was familiar with the more common species that occurred in ice age deposits of Eastern Beringia. Of 380 specimens collected by Geist during his trip up the Old Crow River during 1952, mammoth, horse and bison were most common (Table 2). Evidently at least nine species were represented in his collection, five of which no longer occur naturally in the Yukon Territory.

Brief archeological surveys of the area were conducted in the late 1940s and early 1950s by Douglas Leechman, R.S. MacNeish and Gordon Lowther for the National Museum of Canada.

Vern Rampton, a field assistant of O.L. Hughes of the Geological Survey of Canada, made a geological reconnaissance of the Old Crow River in 1962 during which he collected some fossils. A specimen that particularly attracted my attention was a long, robust antler beam which corresponds most closely to specimens from Alaska referred to "*Cervalces alaskensis*." I believe that these, and other comparable specimens which have been collected since, represent the giant moose, *Alces latifrons*, which had been reported previously only from Eurasian ice age deposits. Three years later, Corporal L.N. Bates of the R.C.M. Police made another small collection of bones from deposits along the Old Crow River. Both collections were given to the National Museums of Canada.

Table 2. List of Pleistocene mammal specimens from Old Crow River, Y.T. collected during 1952 and identified by O.W. Geist (1956).

SPECIES	NUMBER OF SPECIMENS COLLECTED	% OF TOTAL COLLECTION
Mammoth	126	33.2
Unidentified	86	22.6
Horse	74	19.4
Bison or Muskox *	53	14.0
Bison	18	4.7
Caribou	8	2.1
Muskox	6	1.6
Giant beaver	3	0.8
Moose	3	0.8
Beaver	2	0.5
Wolf	1	0.3
TOTALS	380	100.0

* Probably mainly bison (C.R.H.).

Dawson Area

G.M. Dawson was the first of a series of Canadian geologists, mainly working for the Geological Survey of Canada, to mention Pleistocene mammal remains from the Yukon Territory. He (Dawson 1894, pp. 1-2) credited Robert Campbell of the Hudson Bay Company with originally discovering mammoth fossils there, and gave the following quotation from a brief account by Campbell of his exploration of the Yukon River between 1840 and 1852: "I saw the bones, heads and horns of Buffaloes; but this animal had become extinct before our visit, as had also some species of Elephant, whose remains were found in various swamps. I forwarded an Elephant's thigh-bone to the British Museum, where it may still be seen." Sir John Richardson identified the bone as a tibia rather than a thigh-bone, and referred it to *"Elephas primigenius"* (=*Mammuthus primigenius*, the woolly mammoth). The skeleton from which this bone came was said to be complete when found, but most of the bones were lost. Campbell later remarked that the bones were found near the former site of Fort Selkirk, at the juncture of the Lewes and Pelly rivers (probably the junction of the Pelly and Yukon rivers about 130 km southeast of the Dawson Area). Dawson (1894, p. 3) also noted that gold miners had frequently seen mammoth bones farther down the Yukon River, particularly in the vicinity of Fortymile River, which lies

about 60 km northwest of the Dawson Area.

Dawson (1901, p. 185A) also recorded a fragmentary bison skull from Gold Run Creek. Presumably this is the specimen (NMC 7392; Harington and Clulow 1973, pp. 735-736) that was collected by R.G. McConnell in 1900. Whiteaves (1903, p. 241) discussed it and three other *Bison crassicornis* cranial fragments from Dominion Creek, Bear Creek and Bonanza Creek - all in the Dawson Area.

In the course of investigations on behalf of the Muséum d'histoire naturelle de Paris, Obalski (1904, p. 216) visited the Dawson Area, and was able to identify remains of the following Pleistocene mammals: mammoth, mastodon, muskox, bison or buffalo, moose, caribou, wapiti, mountain sheep and horse. Lambe (1905), the newly appointed Verbebrate Paleontologist with the Geological Survey of Canada, listed only nine Pleistocene and postglacial mammal species (only a few of which were from the Yukon) for Canada to 1904. Evidently he had not seen Obalski's report.

In a discussion of the low level creek gravels of the Dawson Area, McConnell (1905) stated: "The creek gravels frequently inclose leaves, roots and other vegetable remains and also bones of various extinct and still existing

northern animals, such as mammoth, the buffalo, the bear, the musk-ox and the mountain sheep and goat." Possibly McConnell confused an adult female thin-horn sheep *(Ovis ?dalli;* cranial fragment NMC 17411) that he collected at Thistle Creek in 1901 with that of a mountain goat *(Oreamnos)*. This fossil, with its relatively small, straight horncores, could easily be mistaken for a mountain goat (Harington 1971b, p. 1093). In addition to NMC 17411 and the *Bison crassicornis* specimen mentioned previously, McConnell also collected a cranial fragment of an adult male *Ovis ?dalli* (NMC 17387) from Thistle Creek.

While working for the United States Biological Survey in the summer of 1904, W.H. Osgood (1905a, p. 173; 1905b, pp. 254-255) visited the Dawson Area. He met J.B. Tyrrell of the Geological Survey of Canada, who presented him with two cranial fragments of the extinct muskox *"Scaphoceras tyrrelli" (= Symbos cavifrons)* and a well preserved American mastodon *(Mammut americanum)* tooth, which are now preserved in the Smithsonian Institution collections. The more complete of the two *Symbos* specimens (USNM 2555) came from Lovett Gulch on Bonanza Creek. The mastodon tooth was collected on Gold Run Creek. These reports extended the known range of both Pleistocene

species much farther north. Subsequent papers (Anonymous 1906; Osgood 1907) dealt with two bison specimens from the area.

An interesting coincidence of efforts to collect important ice age mammal specimens in the Yukon and Alaska occurred in 1907, when field parties of the Smithsonian Institution, led by C.W. Gilmore, and of the American Museum of Natural History, led by L.S. Quackenbush, converged on Dawson. Obviously both groups were after "big game" like the remarkably well preserved Berezovka mammoth from the Siberian tundra that had been excavated in 1901.

Gilmore arrived first on June 14 and departed for Alaska on June 22. His goals were to secure remains of large extinct vertebrates and to investigate the causes that led to their extinction. Gilmore (1908, pp. 5-6) assessed fossil collecting in Dawson as follows: "Scattered remains of Pleistocene mammals are commonly found in the diggings of this region, but the result of diligent inquiry regarding the finding of complete or partial skeletons in the mining operations conducted here were not encouraging. In only one instance were we told of the finding of an accumulation of bones such as would lead one to believe that an entire skeleton or any considerable part of the skeleton of a single individual had ever been found.

The single case mentioned was that of the remains of a mammoth (*Elephas primigenius*) disinterred while sinking a shaft on Quartz Creek in March 1904. The skull and tusks were recovered intact, but, according to our informant, although surrounded by a mass of other bones, no attempt had been made to preserve them." Gilmore (1908, p. 15) picked up parts of mammoth, bison, horse and moose in the talus from Magnet Gulch. At Fox Gulch, about 2 km downstream from Magnet Gulch on the left limit of Bonanza Creek, he was shown many fine skulls and other skeletal parts of the same species. A complete mammoth skull and three bison skulls were seen at Fox Gulch.

After arriving in Dawson on July 19, 1907, Quackenbush (1909, pp. 88, 89) spent three days examining several collections of ice age mammal fossils that had been found in the vicinity, his object being to collect specimens for the American Museum of Natural History. He described a section from Fox Gulch on Bonanza Creek as consisting of bedrock overlain by from 10 cm to 1.2 m of gravel, which was covered by 6 m or more of muck. Quackenbush (1909, p. 91) noticed a small mammoth tusk projecting from just above the gravel unit, and the radius of a large bear within about a metre of it on the same level. G.T. Coffey, who was in charge of the operations, said that all fossils came from a

small area near the head of the gulch, where they lay in the muck on top of the gravel or partly embedded in the gravel. Quackenbush recorded the following additional specimens from the site: bison (33 "bones", seven skulls, two mandibles); mammoth (one skull, two molars, several damaged tusks); horse (one fragmentary pelvis). A list of 14 species of Pleistocene mammals from the Dawson Area recorded by Quackenbush (1909, pp. 126-127) is given in Table 3.

Lambe (1911a, b) reported an interesting find of an extinct short-faced bear cranium from Gold Run Creek. It was collected in 1909 and is the largest known cranium of *Arctodus simus yukonensis* (Harington and Clulow 1973, pp. 699-700). In the following year (1912), Lambe reported five species of Pleistocene mammals from the vicinity of Dawson that had been collected by D.D. Cairnes of the Geological Survey of Canada, and listed Canadian ice age mammals known to him. He recorded 18 species for Canada of which 14 had been reported from the Yukon Territory (10 of which had only been found in the Yukon). At that time, Yukon Pleistocene mammals were better known than those from any other province or territory in Canada because of the abundance of well preserved remains in that part of the unglaciated region, and because they were being uncovered rapidly by booming placer operations.

Table 3. List of Pleistocene mammal species of the Dawson Area, Y.T. recorded by L.S. Quackenbush (1909).

SPECIES	REMARKS
Mammut americanum (="*Mastodon americanus*") - American mastodon	- Obalski (1904, p. 216) saw mastodon remains in the area. Maddren (1907, p. 7) considered this an error, but there are two definite records from branches of the Indian River (Gilmore 1908, p. 30). Other specimens have been found since.
Mammuthus primigenius (="*Elephas primigenius*") - woolly mammoth	
Equus sp. - horse	
Bison crassicornis - large-horned bison	
Bison bison occidentalis (="*Bison occidentalis*") - western bison	
?*Boötherium* sp. (="*Boötherium bombifrons*") - extinct muskox	- This identification, made from a photograph taken by T. Obalski on Gold Run Creek in July 1903, is questionable (Harington and Clulow 1973, p. 734).
Symbos cavifrons (="*Symbos tyrrelli*") - extinct muskox	- Quackenbush saw an incomplete skull from Magnet Gulch, Bonanza Creek in 1907.
Ovibos moschatus - muskox	
Ovis sp. - *mountain sheep*	- Quackenbush examined an incomplete skull from near Hunker Creek in 1907.
Alces sp. - moose	
Rangifer sp. - caribou	
Cervus elaphus (="*Cervus canadensis*") - wapiti	- An 18-inch tine from near Hunker Creek was seen by Quackenbush in 1907.
?*Ursus* sp. - bear	- Perhaps this specimen represents *Arctodus*, the extinct short-faced bear, rather than the brown bear.
Canis sp. - wolf	- A fairly complete wolf skull from Pleistocene deposits near Hunker Creek was examined by Quackenbush in 1907.

J.B. Tyrrell (1912, p. 35) listed 15 species of ice age mammals that he considered to be represented by fossils in Pleistocene gravels of the Dawson Area. As with most lists of this nature it is difficult to say what fossils it is based on and who identified them. The list is probably derived from Quackenbush's (Table 3). I question particularly the identification of *Boötherium bombifrons* and *Ursus*.

In a review of extinct North American bison, Hay (1913, pp. 167-168, 180-181) commented on and figured two Pleistocene bison cranial fragments from near Dawson. A fairly complete cranium (AMNH 13721) collected by Quackenbush at Fox Gulch he perhaps incorrectly refers to *Bison occidentalis:* it is probably *Bison crassicornis*. Another cranium with complete hornsheaths from Bonanza Creek displayed in the Golden Gate Park Memorial Museum, San Francisco, is referred to *Bison crassicornis*. Mastodon and additional mammoth remains, mainly molar teeth, were reported from the area by Lambe (1914); and Holland (1915) recorded a *Bison crassicornis* skull from the Dawson Area deposits.

In 1917 Hay described one of the most important members of the Pleistocene fauna from the region as a new species of small, broad-skulled horse, *Equus lambei*. The type specimen (USNM 8426) is a complete skull that was

unearthed on Gold Run Creek in 1903. It was purchased by the Geological Survey of Canada and was loaned to O.P. Hay of the Smithsonian Institution for examination (Harington and Clulow 1973, p. 708). Six years later Hay (1923) described two additional specimens of this kind.

Clark (1927) described another *Bison crassicornis* skull from the area. H.S. Bostock of the Geological Survey of Canada made an interesting collection of ice age mammal fossils from Miller Creek near Dawson in 1932. Four species are represented in this collection, which is in the National Museums of Canada: *Mammuthus* cf. *primigenius*, *Equus (Asinus) lambei*, *Rangifer tarandus* and *Bison crassicornis* (Porsild *et al.* 1967, p. 113). The most recent contribution on Yukon fossil mammals by a geologist was published by the late M.Y. Williams (1937). Three *Bison crassicornis* crania from the Dawson Area are described in the publication. Two skulls were found on Bonanza Creek, and the locality of the third is unknown.

In his thesis on the paleobotany of the Pleistocene muck deposits of the Dawson Area, Campbell (1952, pp. 58, 101) remarks that at Hunker Creek "Remains of certain moose-like animals are found in the lowermost silt beds a little above 'grade', while Pleistocene horse and some forms of

giant bison and musk-ox appear in the region of interspersed coarse beds. At grade level a few remains of mammoth are found, and in the levels dug by the dredge below grade, considerable amounts of ivory are recovered, often in good condition. Mastodon remains are very rare in the Klondike, having been recovered only once or twice and then from mucks of doubtful position." To his knowledge no remains of flesh and hide were reported from the Dawson Area, although bones were plentiful. He found, or was present when others found, remains of the following Pleistocene mammals at Hunker Creek: "Grizzly bear {possibly *Arctodus* rather than *Ursus*, the grizzly or brown bear, C.R.H.}, Horse, Wapiti, Moose, various extinct Moose-like cervids, Bison of several kinds, various Musk-ox-like Bovids, and Mammoth." Campbell's was the first attempt at a detailed paleoenvironmental study of the area based on paleobotanical evidence.

Further data on fossil mammals as related to Pleistocene stratigraphy in the area were provided incidentally with a description of a pathological mammoth tooth from Hunker Creek by Hunter and Langston (1955, p. 675). This information was derived from the field records of O.L. Hughes, who made valuable collections of Yukon Pleistocene vertebrates for the National Museum of Canada during the 1960-1965 period.

In a study of Pleistocene wapiti of Alaska and the Yukon Territory, Guthrie (1966, pp. 50-51) illustrated a large antler of *Cervus elaphus* from Sulphur Creek in the Dawson Area.

It is easy to see a few general trends affecting the study of Pleistocene mammals in the Old Crow and Dawson areas of the Yukon during this period. Specimens were first collected by explorers, traders and missionaries and donated to the British Museum (Natural History). The next stage, beginning about 1900 was characterized by reconnaissance and collecting trips of Americans, mostly representing large museums in the eastern United States. The last of any note was Geist's collecting trip up the Old Crow River in 1952. Obviously, Canadians generally lacked expertise in the study of Pleistocene vertebrates and were not very concerned with preserving them as part of the nation's heritage during this period. The fact is clearly demonstrated in cases where valuable specimens collected by Canadians were donated by them to foreign museums. Certain parallels may be seen in the Canadian dinosaur rush (Colbert 1968, pp. 175-200). Many of the most remarkable dinosaur specimens from southern Alberta and Saskatchewan are found in museums abroad.

PRESENT WORK - 1966 to 1975

Old Crow Area

In addition to discussions with O.L. Hughes and L.H. Green of the Geological Survey of Canada, the following comments by H.S. Bostock (1961, p. 118) stimulated my interest in the Old Crow Basin as a study area: "The explorers in the northern Yukon from the early days have remarked on the tusks seen there, and the Indians are reported as saying that the course of the Old Crow River was the best locality in Alaska and the Yukon to find them. Certainly the geological setting of the Old Crow Plain with its recent subsidence and unglaciated character suggests that it should be." Field work began in 1966 and has continued each year until the present, except for 1969, 1970, 1972 and 1974.

1966 - Collecting took place between July 2 and August 17. My field assistant was Peter Lord. The first three weeks were spent on a reconnaissance of the Old Crow River. Specimens were collected at 34 localities between the mouth of the river and Timber Creek. My goal was to find the most productive fossil localities and the most complete and clearly exposed stratigraphic sections for detailed

examination in the future. Horse, mammoth and bison specimens were most common. Moose, giant moose *(Alces latifrons)*, caribou, muskox *(Boötherium)*, mastodon, fox, ground squirrel, fish and bird remains were rarer.

At Locality 14N a fleshing tool made from a caribou tibia was found with mammoth and other Pleistocene mammal remains. Realizing the significance of the artifact, I showed it to W.N. Irving, then an archeologist with the National Museum of Canada, who was excavating a Kutchin site on the Porcupine River near the settlement of Old Crow. Another week-long trip was made up the Old Crow River in order to show Irving Locality 14N.

A reconnaissance trip was made up the Porcupine River, the lower Bell River, and the lower third of the Eagle River from August 6-13. A few promising localities were noted on the Porcupine River, but fossil collecting on the lower Eagle River was much poorer than on the Old Crow River.

1967 - Field work lasted from June 30 to August 22. My field assistant was Peter Lord. During the first week of July we travelled down the Porcupine River from Old Crow, in order to examine three of the most complete stratigraphic sections in the region. Mollusc shells for radiocarbon

dating, and rodent, fish, beetle and plant remains were collected from Wisconsin age deposits at Porcupine Locality 100 about 10 km south-southwest of Old Crow (McAllister and Harington 1969). A significant discovery at this site was a highly oxidized, compacted basal unit containing large tree trunks, beaver-cut sticks and many large spruce cones. I tentatively interpreted it as having been deposited in an interglacial period. This unit had been covered by slumped material when Hughes had visited the site earlier.

Fossils were excavated *in situ* (but not in primary position) at localities along the lower part of Old Crow River, south of Johnson Creek, from July 7-22. Excavated material consisted mainly of mammoth, horse, moose, caribou and rodent specimens. Since these fossil-bearing deposits were relatively high on the stream banks, the unusually high waters of the Old Crow River prevalent during the summer had little effect on our work.

A late Wisconsin fossil deposit was discovered near the top of a bluff at Locality 11(1) by a field party under W.N. Irving. Two well-preserved large-horned bison crania and associated material were collected there. This find was important in establishing the type of variation between males and females of *Bison crassicornis*, and, so far, provides the

last evidence of the species in that region. Further excavation at Locality 14N yielded remains of beaver, giant beaver, mammoth, horse, muskrat, ground squirrel, fish and bird.

On July 23, Irving and I made an aerial reconnaissance of the Eagle River in an attempt to locate promising archeological and fossil sites. Irving, T. Hamilton, a Pleistocene geologist from the University of Alaska, and I examined in detail the stratigraphy at Localities 10, 11, 12, 14, 14N and 15. Fossils were excavated at various levels on the steep bluffs at Localities 12 and 15.

Many bones, including the skull and teeth, of an individual mammoth were collected during a reconnaissance trip up the Whitestone River between July 27 and August 9. This was the first time I had encountered a partly-articulated Pleistocene mammal skeleton. The discovery was exciting because I was led to it by following up an old story, which had been handed down to some of the natives of Old Crow, of "monsters" in that area.

During August 14 to 19, many fossils were excavated along the Old Crow River, and a few new and promising localities such as Locality 44 were found upstream from the mouth of Timber Creek.

<u>1968</u> - Field work took place between June 9 and August 7. My field assistant was Peter Lord. O.L. Hughes and I carried out co-operative stratigraphic - paleontological studies during the first two weeks of this period. We spent June 12-14 at Locality 100 on the Porcupine River, prior to examining Pleistocene sections on the lower Old Crow River. A well-preserved giant beaver *(Castoroides)* mandible with teeth was collected at Locality 100, and Hughes confirmed my earlier report of a basal organic unit there suggesting a relatively warm climate. We collected paleobotanical specimens from the basal unit for study by L.V. Hills of the University of Calgary.

We surveyed fossil localities on the lower half of the Old Crow River as far upstream as Locality 32 from June 15-19. Hughes noted signs of cryoturbation in the lower levels at a number of localities, providing a further criterion for their separation from the higher sedimentary beds. Pollen and radiocarbon samples taken by Hughes were used later by Lichti-Federovich (1973) in her reconstruction of the late Pleistocene botanical history of the Old Crow Basin. Hughes departed on June 21.

From June 23 to July 13, emphasis was placed on discovering new localities in the upper part of the Old Crow

River, which I had not surveyed previously. Specimens were found as far upstream as Thomas Creek. Some of the more promising localities upstream from Black Fox Creek were excavated.

A reconnaissance of the lower part of the Bluefish River was attempted from July 17-19, but had to be abandoned because of low water.

Excavations were carried out on the lower Old Crow River between Black Fox and Schaeffer creeks. New Pleistocene vertebrate sites were discovered, bringing the total in the Old Crow Area to 73. Interesting specimens represented: lemming, hare, black-footed ferret (Anderson 1973), a camelid, muskox *(Ovibos)*, wolf and waterfowl. Some bones, apparently modified by early man, were collected. Perhaps the most unexpected find was a scimitar cat *(Homotherium)* mandible - a northward Pleistocene range extension of about 3200 km.

<u>1971</u> - Pleistocene vertebrate fossils were collected during the period July 1 - August 12. My field assistants were G.R. Fitzgerald and Charlie Thomas. July 3-4 was spent at Locality 100 on the Porcupine River. The basal unit was checked carefully again and further organic samples were

collected, but no trace of vertebrate remains was found.

The first trip up the Old Crow River took place from July 4 to 23. We camped at Locality 11A, a point bar consisting of layers of pea-sized gravel, sand and vegetation. The site, discovered in 1970 by a field party under W.N. Irving, is one of the richest concentrations of ice age vertebrate remains in the Old Crow Basin. The most remarkable specimen collected from the site is a cranial fragment with horncores of *Soergelia* cf. *elisabethae*, a primitive muskox, which until then was only known from early middle Pleistocene deposits in Germany. Seven test trenches were cut into the bar and many specimens were collected. A new site (Locality 74) produced many fossils, the highlight of which was the discovery of the first specimen of the extinct muskox *Praeovibos* from the Old Crow Basin. This partial skull with horncore confirmed Robert McDonald's earlier find on the "Upper Porcupine River."

Locality 11(1) yielded more *Bison crassicornis* material, including a cranium with horncores. Sediment and peat samples were taken from the fossil zone for paleoenvironmental studies by J.V. Matthews. On July 12, Charlie Thomas excavated an interesting black obsidian biface at Locality 20 - the first finely-flaked stone artifact we had

seen in the deposits carrying remains of ice age mammals in the Old Crow Basin. Many fossils were collected at this site including pika, wolverine, ground squirrel and vole. At one point our excavation near the base of the bluff at Locality 20 was stopped by permafrost. The farthest point upstream that we reached was Locality 65.

The goal of the next trip up the Old Crow River (July 27 to August 9) was to find new localities and excavate old ones upstream from Timber Creek. A few days (August 1-4) were spent excavating with trowels and sluicing the gravels at Locality 29 in order to pick out smaller specimens, such as rodent, bird and fish. During this period, I collected a gray chert flake, which had evidently been struck from a core, and the proximal part of a caribou antler showing four polished facets on the base. I speculated that it could have been used as a pestle.

Most of the site which Peter Lord and I had excavated at Locality 44 in 1968 had been eroded away, so efforts were directed to obtaining samples of small vertebrates, beetles, mollusc shells, seeds, and wood for radiocarbon dating from finer sediments of the same unit a few metres downstream from the original site. Matthews was able to provide a great deal of information on the paleoenvironment

that existed there during the deposition of the fossil deposits by studying our samples from this locality.

1973 - On July 2, with O.L. Hughes and N. Rutter of the Geological Survey of Canada, a helicopter survey was made of the southern Old Crow Basin, and the upper parts of the Driftwood and Berry river valleys. We later visited a site on the lower Rock River, where Hughes had found fossil elephant remains during the previous year. Evidently the material had come from a unit near the base of a high bluff. Much slumping had occurred since, and the fossil-bearing unit was masked. We proceeded to the lower Eagle River, where a caribou toe bone and part of a large cervid (?) metacarpal were collected along the shore.

Hughes had visited Locality 12 and gave me part of a caribou mandible and the metatarsal of a small horse from that site. Other fossils, including bison and wolverine specimens, from Locality 81 near the mouth of Surprise Creek were donated by D. Showalter and D. Reid who were working for the Canadian Wildlife Service. On July 4, I accompanied them on an aerial biological survey to Herschel Island, where a number of Pleistocene vertebrate fossils had been found previously. A small seal scapula fragment was collected half way up an 18 m coastal bluff on the west side of Pauline Cove.

Bob Mackenzie, who was living there, had collected part of a hornsheath that had characteristics of *Bison crassicornis* hornsheaths.

My intention this year was to spend long periods excavating at some of the most productive sites, such as Localities 11A, 20, 22, 27W and 44, in order to get a better idea of the variety of Pleistocene vertebrate species in the Old Crow Basin, and in the hope of finding further critical evidence of early man. With Charlie Thomas and G.R. Fitzgerald as assistants, I started up Old Crow River on July 5. The next day we camped at Locality 11A, where the bar was so densely covered with fossils that it was difficult not to step on them when landing from the boat. It was more efficient to excavate trenches into the bar than to try to wash away the finer sediments with a hose (water was absorbed too rapidly by the sand and gravel). Among the bones collected were those belonging to: fish, bird, muskrat, beaver, giant beaver, bison, mammoth, large and small horse, ground sloth, caribou, muskox, camel, moose, wolf. I collected a fine gray chert flake that had been struck from a core. Charlie Thomas found the left part of a *Bison crassicornis* cranium with horncore partly buried in surface sand at the upstream end of the bar. From its relatively fresh appearance, which contrasted with the almost blackish

staining of most of the other fossils, I thought it had been washed down from the mouth of the gully at Locality 11(1), which was a few kilometres upstream. A radiocarbon date on bone from the skull that I received later suggested that this was so. More late Wisconsin bison material was collected at Locality 11(1). Locality 14N was virtually destroyed as a collecting site by a combination of clay slumping down from the bank above, and by a thick cover of stream silts that masked the lower bank and the fossil-bearing unit.

A number of interesting specimens were collected at Locality 66: ground sloth, scimitar cat, and wolverine. A large sample of shells was collected from the fossiliferous gray silt overlying the basal clay unit at Locality 64, in an effort to obtain further specimens of *Fluminicola*. A single specimen of this coiled shell from Locality 64 had been identified by A.H. Clarke (personal communication 1970), who stated that it was a significant northerly range extension and indicated that warmer climatic conditions once prevailed in the area. A black-footed ferret mandible was the highlight of a collection from a new site, Locality 83.

On July 19 I collected a mammoth tooth that was definitely in place near the upper surface of the basal clay

unit at Locality 12. Few Pleistocene vertebrate specimens have been found in this unit, which is presumably beyond dating by the radiocarbon technique. A few days were spent at Locality 11A, and 10 trenches 1 m wide x 1 m deep and up to 12 m long were excavated from the shore back into the bar deposits. Careful excavation with trowels yielded many fish, bird and rodent fossils. Outstanding specimens were: a maxilla fragment with teeth of the short-faced bear *Arctodus*; a mandible with teeth of a large, extinct marten *(Martes nobilis)*; and, on July 25, Charlie Thomas excavated a large gray chert biface that may have been used as a knife. We returned to Old Crow on July 26.

A second trip up the Old Crow River lasted from July 30 to August 8. Between August 2 and 3 enough matrix was excavated at Locality 44 to fill two large boxes in order to facilitate further paleoenvironmental work by Matthews on the fossiliferous layer (Unit 2). Three pails of matrix from that unit were screened, dried and bagged. Many specimens were collected at Locality 27W near the mouth of Timber Creek from August 4 to 6. The fossil-bearing sediment was well suited for wet-screening, and many bags of concentrate were collected for study in the laboratory. A grayish chert blade was excavated from the oxidized fossiliferous gravels overlying the basal clay unit at this site on

August 5. Nine new localities were discovered between the mouths of Timber and Black Fox creeks. More *Bison crassicornis* material was collected from Locality 11(1).

1975 - Field work took place from July 1 - August 21. The first week of July was spent in co-operative studies with members of the Yukon Refugium Project (O.L. Hughes (geologist), R.E. Morlan (archeologist), C. Schweger (paleobotanist) and an associate, R. Bonnichsen (archeologist). During the rest of the field season in the Old Crow Area, I was assisted by G.R. Fitzgerald and C. Thomas. Old Crow River Localities 11, 11A, 12 and 44 and Porcupine River Locality 100 were visited from July 1-7. At Locality 44 a pika mandible was collected *in situ* from sediments containing wood, conifer cones and mollusc shells approximately 30 feet (9.1 m) above river level. Few fossils were found along the base of the bend at Porcupine River Locality 100, largely because of the degree of slumping that had occurred after the high water of the spring melt. At Locality 11, O.L. Hughes found a horse lower cheek tooth *in situ* approximately 3 feet (0.9 m) above stream level in the upper organic part of the basal clay unit. Ironstone appeared to be characteristic of that particular stratigraphic level. Part of a mammoth limb was found in a similar stratigraphic position about 5 feet (1.5 m) above stream level farther downstream at Locality 12. The

period July 7-12 was spent on a reconnaissance of Johnson Creek. Although a good collection of fossils was obtained at Locality 71 and a few bones were collected on the surface near the base of a number of the bluffs on the lower part of the creek, no important fossil vertebrate localities were discovered. At the farthest locality upstream on Johnson Creek, samples of wood were taken for radiocarbon dating from tree stumps that appeared to be rooted in organic silt at least 5 feet (1.5 m) from the surface. Tundra now occupies the surface in this region.

From July 12 - July 22 four new localities were found between Locality 14N and the mouth of Black Fox Creek. Most of the time was spent excavating at Localities 20 and 22. At the former, a mammoth molar was found *in situ* in the basal clay unit. At the latter site a black chert "knife" was found on the surface by G.R. Fitzgerald. Among the specimens collected on the bar at Locality 66 were: wolf, wolverine, giant beaver, muskrat, mammoth, horse, moose, caribou. A camel toe bone (first phalanx) was collected on the bar at Locality 23. The only other find of note during this trip was a beaver-cut stick collected *in situ* in the basal clay unit approximately 15 feet (4.6 m) above stream level at Locality 96. It indicates that beavers (Castoridae) occurred in the region during ?Illinoian time with mammoth,

horse, and caribou. This site has one of the longest continual exposures of the basal clay unit I have seen on the Old Crow River, and would be a good place to study it.

The second trip up Old Crow River took place between July 27 and August 16. At Locality 11(1) the tibiofibula of a small rodent was found in place in an oxidized sandy layer in gray and orange banded silts about 15 feet (4.6 m) above creek level and well above the upper surface of the basal clay unit. The specimen may be of early Wisconsin age. On July 28, I found a new locality (106). Overlying the basal clay unit at this site was more than 18 feet (5.5 m) of organic matter with a rooted stump, small logs, layers of woody detritus, lenses of whitish mollusc shells, and beetle remains. It was overlain by approximately 33 feet (10.1 m) of buff and gray banded silts with thin organic layers, at least 2 feet (0.6 m) of late Wisconsin glacial lake clay and 15 feet (4.6 m) of indeterminate postglacial surface deposits. No bones were found *in situ* in the thick organic unit, which I correlate with the fossiliferous zone of ?Sangamon age at Locality 44, but a beaver cut stick was collected *in situ* 1 foot (0.3 m) below the stump. This locality when studied in detail promises to produce a great deal of information about the late Pleistocene environment of the Old Crow Basin.

On July 29, a grayish black, veined chert flake made by man was collected from the surface of a gravelly bar at Locality 32E. At Locality 60 a lower horse cheek tooth, and a caribou antler base with part of the braincase attached were excavated from gravels that appeared to be in the upper part of the basal clay unit. I later cleaned a large section of the basal clay unit, exposing what seemed to be a section of a stream channel cut into the lower inorganic part of the basal clay. The channel was at least 11.5 feet (3.5 m) across and 4.1 feet (1.3 m) deep and lined from outside to inside by successive layers of: (1) oxidized gravel containing part of a horse metapodial, part of an elephant (probably mammoth) tusk and a fragment of the root of an unidentified tooth; (2) sand; (3) organic detritus and twigs; (4) a fill of relatively flat lying oxidized sandy silt with some thin bands of organic material. I consider that this channel represents the sequence of deposition expected in a cut-off meander, with a steadily decreasing rate of stream flow. If the relatively sterile basal clay unit surrounding the channel represents an Illinoian Glacial Lake Old Crow deposit, then probably the downcutting phase of the channel would have occurred at the close of Illinoian time and most of the channel fill would be attributable to the early Sangamon phase. In turn, this would suggest that the fossiliferous sediments at Locality

44 would be of middle to late Sangamon age.

On August 3, a caribou naviculocuboid that had been faceted on the proximal surface was collected from the head of the bar at Locality 108, with goose, giant beaver, mammoth, horse, caribou and bison fossils. The next day we explored the banks near the mouth of Surprise Creek and then began the return journey to Old Crow. Charlie Thomas collected a well-preserved red fox cranium from the surface at Locality 115. Locality 127 seemed to be a promising site, because 15 minutes of excavation yielded 10 valuable specimens both large and small.

At Locality 45, a tusk and fragments of an elephant limb bone were found *in situ* in banded silts approximately 10 to 15 feet (3.0 to 4.6 m) above the upper surface of the basal clay unit and 40 feet (12.2 m) below the surface of the section, suggesting an early to middle Wisconsin age. The specimens were collected with woody material from the same lens in order to obtain radiocarbon dates. Gravel patches along the river downstream from Locality 132 were definitely more productive of fossils than those upstream from that site. A lower cheek tooth of a horse, faceted by man on the labial surface, was collected on August 7 at Locality 134. An interesting artifact was collected at

Locality 29. It consists of the proximal part of a caribou antler from which the brow tine had been removed and the base bevelled in. Cut marks can be seen on the bez tine "handle". Presumably this artifact was used like a hammer for removing flakes from a stone core. Two other artifacts had been found at this locality previously, making it of great interest to archeologists. Another camel phalanx was collected here. On August 10 at Locality 138 I found a complete black chert projectile point on the surface of the basal clay. *Anodonta beringiana* shells and Pleistocene mammal bones were found with it.

Locality 143, a large area of exposed river bottom, yielded two pails of good specimens. Among them was the distal end of a horse humerus with facets on either side of the olecranon fossa that obviously had been made by man. On August 14 the organic horizon at Locality 106 was sampled. A cranial fragment of the extinct muskox *Symbos* was found later at Locality 21. We arrived at Old Crow on August 16. Approximately 50 new localities had been discovered during the summer.

A substantial collection of well preserved *Bison crassicornis* bones from Locality 11(1) was transferred to the Quaternary Zoology section by R.E. Morlan. They add to

the abundant collection of large-horned bison specimens from that late Wisconsin site.

Dawson Area

1966 - Field work took place during two periods from June 12 - July 1 and from August 17-28. On June 14, O.L. Hughes and I visited the recently abandoned Fant and Norback site on Hunker Creek, where hundreds of Pleistocene mammal fossils were found during the previous few years. We then proceeded to Harold Schmidt's operation on Dominion Creek and I visited several other sites on Gold Bottom, Bonanza and Eldorado creeks.

On June 18, Hughes showed me other localities on Dominion and Sulphur creeks. Most of the active placer miners in the area were visited and proved willing to keep vertebrate remains for the National Museums of Canada. The commonest remains collected were of horse, mammoth and bison. Caribou and mountain sheep specimens were less common, and American mastodon, giant moose *(Alces latifrons)* and muskox *(Symbos cavifrons)* were rare. Samples of what appeared to be organic clay in the White Channel gravels were taken for paleobotanical analysis.

On June 21, Hughes and I examined sites at Stirling Bend and "Ash Bend" (the next bend upstream from Stirling Bend) on the Stewart River. No vertebrate fossils were found beneath sediments of the Reid advance,which is older than late Wisconsin. At "Ash Bend", bison and mammoth specimens were collected below a layer of volcanic ash that has been radiocarbon dated at over 42,900 years old. On June 22 we visited various sites farther down Stewart River by boat. I received a few *Bison crassicornis* cranial fragments from K. Djukastein on Brewer Creek.

Articulating humerus and ulna fragments of the extinct American lion *(Panthera leo atrox)* found on Harold Schmidt's ground on Dominion Creek proved to be the first record of the species for Canada (Harington 1969). Another interesting find consisted of viable arctic lupine seeds, which Schmidt had collected earlier with a collared lemming skull from Pleistocene deposits at Miller Creek. Before leaving for Old Crow, I visited O. Medby and J. Lynch at Glacier Creek and Miller Creek. Although no fossils were collected, Lynch told me that J.F.V. Millar, an archeologist, had taken a large pile of ice age mammal bones that had been amassed by J.P. Miller near the dredge on Glacier Creek. This collection is apparently at the University of Calgary. However, it could not be located there in 1976.

From August 17 to 28, I revisited the placer operations seen earlier and obtained fossils collected by some of the miners. Many specimens were obtained from G. Heitman on Cripple Hill (Dawson Locality 2), Harold Schmidt on Dominion Creek (Dawson Locality 28), and Ernie Schink on Gold Run Creek (Dawson Locality 32). A few days were spent in reorganizing, labelling and cataloging the Pleistocene mammal specimens on exhibit in the Dawson City Museum.

1967 - Field work was undertaken from June 5 to 28 and August 22 to September 8. A fine horse skull was received from Harold Schmidt on Dominion Creek on June 8. He was using a monitor to wash away frozen muck and said that it broke up the fossils more readily than when his large sprinkler system was used to gradually "melt down" the muck layer. He noticed that about two-thirds of the fossils he had collected the previous year had come from the point where a "pup" (creek tributary) entered Dominion Creek. These are often areas where great thicknesses of muck and vegetation are concentrated.

This observation enabled me to form a hypothesis that most Pleistocene mammal fossils would be found at points on the major creeks which were fed by pups, and that if pups

entered from both sides of the valley near the same point, the fossil concentration would be greater. The reasoning behind the hypothesis is: (a) the pups were the main channels down which the reworked upland loess, with vegetation mats and bones of mammals that had died on the higher steppe grasslands, was washed or moved by mass wastage into the creek bottoms; (b) as these organic loads reached the level of the creek bottoms, they would lose velocity and tend to build up in thickly concentrated masses; (c) the bones, because of their greater density, would become concentrated at the base of the muck near the upper surface of the gold-bearing creek gravels.

The Fant and Norback pit on Hunker Creek, formerly so rich in fossils, had suffered heavy slumping and the surface was nearly covered by vegetation. Promising exposures can be lost rapidly in this country, if the faces of cuts are not kept fresh each year. No specimens were collected at Glacier and Miller creeks, as most of the miners were still stripping vegetation from the surface.

From June 16 to 21, I examined sites in the glaciated Mayo region and had another look at the "Ash Bend" fossil locality on the Stewart River. A few years earlier Pleistocene mammal fossils had been collected by Ed Bleiler

on Highet Creek, near Mayo, but when I examined the area, none was found. Stratigraphic sections were made on the clearest exposures seen on Highet Creek and near Hans Barchan's claim on Johnson Creek. No fossils were seen at Haggart Creek near Acheson's placer operation, but Fred Taylor on Dublin Gulch gave me an astragalus that had evidently been washed down to the floor of Dublin Gulch from organic deposits on its left limit. A large sample, including ostracodes and molluscs, was taken from a marl deposit near the landing strip at Mayo for study by L.D. Delorme. Several bison bones were collected at "Ash Bend" on the Stewart River: one bone was found in place about 4 feet (1.2 m) below an ash layer.

On June 26 excavations at Cripple Hill yielded horse, bison, caribou and mountain sheep fossils. Most of the bones were stained reddish-brown from the iron in the gravel at the base of the muck, from which the fossils came.

On August 24, Ernie Schink donated a good immature Yukon wild ass *(Equus (Asinus) lambei)* cranium, a badger humerus, and part of a caribou skull from Gold Run Creek. Two days later I found an almost complete badger cranium and a Yukon wild ass skull on the right limit of Schmidt's claim on Dominion Creek. A nest containing bones of an individual ground squirrel *(Spermophilus parryi)*, droppings,

seeds from a cache, beetle remains, etc. was recovered from this site.

Half of a wolf cranium and a posterior fragment of an American lion cranium were the most important fossils from Quartz Creek donated by Art Sailer. A highlight of field work in 1967 was the identification of a postglacial muskox of the living variety *(Ovibos moschatus)* from deposits near the surface at Brewer Creek on Stewart River.

<u>1968</u> - Field work was carried out from August 7 to 21. A bison cranial fragment with an unusually long horncore was donated by Lorne Ross from his placer operation on Gold Run Creek (Dawson Locality 33). It is larger than any *Bison crassicornis* horncores I have seen and is referred to the Alaskan bison *(Bison alaskensis)*. Bone from this specimen yielded a radiocarbon date of <39,000 years B.P. Ernie Schink donated horse, bison, caribou and moose fossils. He said that Lamontagne had sold a nearly perfect Pleistocene horse skull, with other bones and tusks from their site, to Alex Seeley from Whitehorse, who was buying fossils at $1 per pound for any kind of bone. Seeley was selling them to tourists. Later, with the help of F.V. Clulow, I was able to trace the horse skull and other bones to a collection at Laurentian University and, ultimately, to publish descriptions

of them (Harington and Clulow 1973, Figure 22).

On August 19, I collected a Yukon wild ass cranium from the right limit of Dominion Creek on Schmidt's ground. Heavy wear on the teeth indicated that this specimen was from a very old horse. Fossils were also collected from Sailer's ground at Quartz Creek and Lunde's claims on Gold Bottom Creek.

1969 - I did not carry out field work during this period, but, at my request, A. Lissey, then of the Geological Survey of Canada, and his assistants kindly visited the placer operations of E. Schink and J. Lamontagne on Gold Run Creek, M. Kinakin on Allgold Creek, and A. Sailer and H. Schmidt on Quartz Creek. The most interesting specimens from Quartz Creek were a nearly complete humerus of a large turkey (*Meleagris* sp.) and the right horncore of a wood bison (*Bison bison athabascae*). The former was collected by Art Sailer and the latter by Harold Schmidt. Wood bison had never been recorded from the Dawson Area before. Arrangements have been made since then to obtain a relative age on the turkey specimen using the amino acid racemization technique developed by Bada (Anonymous 1975, p. 349).

1970 - Field work took place from August 9 to 18. Yukon

wild ass, bison and moose were received from O. Lunde on Gold Bottom Creek. I was able to examine the stratigraphy at Art Sailer's placer operation on Quartz Creek. Most likely the turkey specimen collected the previous year came from the interface between the gold-bearing gravels and the overlying muck unit. Contact was made with Walter Rasmussen, who was preparing ground upstream from Sailer's on Quartz Creek. He said he would be willing to donate fossils to the National Museums of Canada.

Horse, bison, moose and caribou fossils were collected from Schmidt's ground on Dominion Creek. Schink and Lamontagne were closing their operation of Gold Run Creek, which had produced some of the finest and most interesting specimens in the Dawson Area. Horse, caribou, moose and mammoth bones were selected from a number of fossils collected by Ernie Schink. Fossils were also collected at Burgelman's property on the right limit of Dominion Creek.

1971 - In July, T. Morgan and P.M. Youngman of the National Museums of Canada collected Pleistocene bison, caribou and mountain sheep bones from near Mile 110 on the Dempster Highway, while gathering material for displays. The fossils came from an area of melting permafrost on the roadside.

Pleistocene remains had not previously been reported from this area.

Field work took place from August 12-23. I collected a nearly complete horse cranium on Gold Run Creek on August 14. It had evidently been washed into the main creek bed from one of the gullies during the peak of the melt period. A few specimens, mainly mammoth, horse, bison and moose were collected at placer operations on Dominion, Gold Bottom, Quartz, Eureka, and Flat creeks. Sites on Bonanza, and Eldorado creeks were examined with no results. The lack of success in collecting this year was attributed to the fact that many placer miners had moved to new areas, so that older sites productive of bones were abandoned. Other miners were in preliminary stages of preparing ground or had experienced serious equipment breakdowns.

1972 - Much of the time in Dawson (August 11-24) was spent in establishing and monitoring a display of the best Pleistocene mammal specimens collected from the area. Most of the fossils had been shipped from Ottawa, and a few were borrowed from the Dawson City Museum. I gave a talk on Yukon Pleistocene mammals to some 40 geologists who were taking part in an International Geological Congress field trip to the southern Yukon. A few bison specimens were

collected on a bench near Flat Creek, at Ole Lunde's placer operation on Gold Bottom Creek, and on Cripple Hill.

On August 18, some *Bison crassicornis* and mammoth fossils were found in place on the right limit of Gold Run Creek, about 40 feet (12.2 m) from the mouth of a small tributary or "pup". They were exposed on the surface of the gold-bearing gravel, and were covered by at least 13 feet (4.0 m) of muck (the surface had been stripped by bulldozer).

I travelled the length of the Dempster Highway on August 20 in order to see if other exposures of Pleistocene mammals had been found. Neither the Chief Surveyor, Bob Davies, nor any of the construction workers I talked to had observed any. On August 22, Lorne Ross donated a small collection of bison and mammoth bones collected a few years earlier at his old placer site on Gold Run Creek.

A few bison and mammoth specimens were received from Faucher's ground on Glacier Creek. At that site, a specimen was collected for analysis by J. Westgate from a thin layer of volcanic ash about 4.6 m above the base of the muck unit, that was overlain by at least 1 foot (0.3 m) of muck (evidently the upper part of this section had been stripped off). I examined and measured the posterior of a

Bison crassicornis cranium with horncores, and a mammoth tusk found by Walter Yaremcio in 1971 on slumped material on the bank of the Sixtymile River.

1973 - Field work took place from August 13 to 23. On August 13 Fred Berger gave me a small collection of Pleistocene mammal bones (mammoth, wolf, Yukon wild ass, bison, caribou) from Tony Kosuta's property on lower Hunker Creek. He reported that Kosuta's site produced many fossils. On August 15 I examined hundreds of fossils that had been collected at John Erickson's and Herman Leidtke's placer operation on upper Hunker Creek. Most of the bones had been gathered by Leidtke. Specimens representing large-horned bison, woolly mammoth, Yukon wild ass and caribou were most common. A partial mandible with teeth of the extinct muskox *Symbos cavifrons*, most of the ulna of an American lion, and part of a wolf mandible were also collected from this locality (Dawson Locality 16).

While sorting out the fossils from Erickson's and Leidtke's site, I noticed a large, bullet-shaped piece of caribou antler that appeared to have been purposefully shaped for use as a punch. This is the first evidence suggesting the presence of early man in this higher region of the Yukon near the margin of the Wisconsin ice (Harington 1975, p. 5).

I obtained a few fossils from Ole Lunde on Gold Bottom Creek and later talked with Tony Kosuta at his site on lower Hunker Creek. He estimated that he had recovered about 500 pounds (227 kg) of fossil bone from a small bedrock channel filled with gravel and overlain by thick muck. He mentioned that he had found many bison bones, some sheep skulls, a large tusk (for which he received $100 from an Alaskan woman), and a large carnivore skull that he thought belonged to the short-faced bear *(Arctodus)* after seeing one on exhibit in Dawson the previous year. He later donated this carnivore skull to the National Museums of Canada. It turned out to be the best specimen of the American lion found in Canada.

Although no bones were collected on Dominion or Eureka creeks, I found wolf, Yukon wild ass, bison and caribou specimens at Gold Run Creek. A few bison and caribou specimens were collected at Cripple Hill, and I received a Pleistocene horse femur from the Archibald Brothers' claim on Bonanza Creek. Walter Yaremcio donated a very large horse metatarsal from the Sixtymile Area. The specimen is closer in size to metatarsals of a large horse common in the Old Crow Basin deposits, rather than those of the Yukon wild ass generally found near Dawson.

On August 21 Bert Bratsberg showed me places on his site on the left limit of lower Hunker Creek where blackish-stained rooted tree stumps were overlying gold-bearing gravel - their tops had evidently rotted, and all were in turn covered by peat mats. Evidently muck had been stripped from the surface. This suggested to me that trees had been growing in the lower part of the Hunker Creek valley after the time the gold-bearing gravels had been deposited and before the muck had been laid down - perhaps during a relatively warm period. A visit to Walter Rasmussen's claim on Quartz Creek yielded Yukon wild ass, moose, caribou, and bison bones. Most were found at the base of tailing piles or on their surface. Others were in water-washed areas on stripped ground.

1974 - Field work was undertaken during the period August 15 - September 1. No bones were found in the vicinity of Flat Creek, but Clive Nicholson, mining on a bench claim near Lovett Gulch, said he had exposed "stinking clay" above gold-bearing gravel and that bones were found near the interface of the two layers. Mammoth, bison and mountain sheep fossils were identified in a small collection made by Nicholson and his family.

On August 17 I visited John Erickson's placer

operation on upper Hunker Creek. Since 1973, he and H. Leidtke had worked downstream about 180 m and had encountered mining shafts of earlier miners. The wall of frozen muck near the road was about 11 m high. Mammoth, horse and bison bones were identified from the site. The fact that the greatest concentration of bones was found near the upstream end of their cut where May Pup and Mint Gulch joins Hunker Creek, and that the fossils decreased in number downstream from that point, evidently supports the "feeder hypothesis" mentioned earlier. Erickson and Leidtke donated some of the more scientifically important specimens that they had collected to the National Museums of Canada.

Leisure Placers had stripped a lot of ground on lower Dominion Creek, but no bones were noticed there because monitoring had not begun.

On August 18 I travelled to Lost Chicken Creek, Alaska. Wapiti, mountain sheep, the extinct muskox *Symbos*, and a kiang-like horse were among the more interesting specimens in a collection of Pleistocene vertebrates donated by Barbara Purdy from that site. The stratigraphic sequence on Lost Chicken Creek was similar to that at Hunker Creek.

A few fossils were collected between Lunde's and Crockett's claims on Gold Bottom Creek. A stratigraphic section was made at Tony Kosuta's operation on lower Hunker Creek, where I sampled a discontinuous volcanic ash band about 5 m above the base of the muck for analysis by J. Westgate. Two ground squirrel crania that had been washed out of the deposits, and bison and caribou bones that were in place in the muck about 2.5 m above the upper surface of the gold-bearing gravel, were collected. Later a mammoth toe bone was found lodged in the muck face about 3 m above the gravel surface. Tony showed me two fine specimens he had collected from his site: a woolly mammoth palate with partial tusk sockets and two upper molars, and a large mountain sheep cranium with perfect horncores and most of the cheek teeth. He donated the latter specimen to the National Museums of Canada.

Ross Sailer donated a few interesting rodent bones from Dominion Creek to the National Museums of Canada. Some of the bones, evidently from an individual ground squirrel, had been found in a pocket of gray silt (muck) about 1 m above the surface of the gold-bearing gravel. A fragment of a hawk also came from Pleistocene deposits at this locality. Wet screening is required here. I partly reorganized and made better labels for the collection of Pleistocene mammal

bones on display in the Dawson City Museum.

A few mammoth, horse and bison bones were collected from tailings at the operation run by Djukastein and Gatenby where Green Gulch enters Sulphur Creek. Yukon wild ass and bison fossils were collected from Roy Gibson's claims near the mouth of Friday Gulch. Water was high in Gold Run Creek due to a heavy snowfall on August 23 and no fossils were seen.

Walter Rasmussen donated some fossils (woolly mammoth, Yukon wild ass, moose, bison) from Quartz Creek. While collecting at his site on August 26, bison and caribou specimens were excavated from a black, peaty zone with roots and tree (conifer?) stumps found in a depression on top of the creek gravels. This "forest bed" is similar in appearance to that noted in 1973 at Bratsberg's operation on lower Hunker Creek. The caribou bone yielded a radiocarbon date of approximately 5,000 years B.P., suggesting that forest had occupied the area during the hypsithermal period.

During a trip to Glacier and Miller creeks on September 1, I received a few matatarsals and anterior parts of upper and lower jaws of a large Pleistocene horse from Walter Yaremcio. They were excavated from a bench above

Sixtymile River, and may be older than fossils from lower levels in that area.

<u>1975</u> - Field work took place from August 21 - September 1. On August 22, I visited John Erickson's placer operation on upper Hunker Creek. He gave me a well preserved mandible with teeth of the American lion *(Panthera leo atrox)*, and also a sample of about two dozen ground squirrel *(Spermophilus parryi)* droppings from a small exposure of organic material in muck approximately 20 feet (6.1 m) above the gold-bearing gravel on the right limit of Hunker Creek. I collected the posterior part of an American lion skull, and parts of a *Bison crassicornis* skull. On the following day, horse, moose and bison fossils were collected at Lunde's operation on Gold Bottom Creek. G. Burgleman told me of finding what was almost certainly the limb bone of a mammoth with some flesh and hair on it near the head of Dominion Creek about 1945.

Walter Rasmussen gave me some specimens of the Yukon wild ass and bison from his placer operation on Quartz Creek on August 25, and his partner Jack Lacross donated a good mammoth jaw containing RM_3. The following day, Ian Hamilton showed me mammoth, Yukon wild ass, moose and bison fossils from his site at the head of Dominion Creek. I collected

many good specimens of bear, mammoth, Yukon wild ass, caribou, moose and bison on Klaus Djukastein's property on Sulphur Creek. One of the most interesting of these was a bison basicranial fragment with signs of butchering by man. The cut marks were stained dark brown like the rest of the fossil, indicating that they had been made on fresh bone.

On August 27 I collected a canid cranium, which probably represents a dog rather than a wolf. Evidently it had been washed out of muck overlying gold-bearing gravels at Sailer's operation on Dominion Creek. On the following day, I received a good posterior cranium with horncores of the extinct muskox *Symbos* from Clive Nicholson. It came from Trail Gulch. I photographed and measured some woolly mammoth specimens he had collected, one of which (most of a maxilla with teeth) was particularly interesting because, in relation to the massive right tusk, the left tusk was vestigial - apparently a pathological condition. On nearby Cripple Hill I excavated well preserved bison specimens *in situ* 10 inches (25.4 cm) above gold-bearing gravel and 15 inches (38.1 cm) above black schistose bedrock. No good specimens were found on the property of Leisure Placers on lower Dominion Creek, but a sample of volcanic ash was collected in perennially frozen muck 4 to 7 feet (1.2 to 2.1 m) above gold-bearing gravel.

August 29-30 was spent in the Sixtymile Area, where I sorted out a large collection of fossils collected by Adrien Brisebois and Walter Yaremcio from a new excavation made by Brisebois approximately 1 mile downstream from the mouth of Miller Creek on the left limit of Sixtymile River. The collection is the largest recorded from this area. It includes: American lion, woolly mammoth, Yukon wild ass, medium-sized horse, caribou, large-horned bison, tundra muskox and mountain sheep. Traces of dried flesh were found on a woolly mammoth cranial fragment and on the lower part of a Yukon wild ass tibia. I examined the site, made a stratigraphic section, and found bone in place in the muck 2 feet (0.6 m) above the surface of the gold-bearing gravel. Later I measured a well-preserved *Bison crassicornis* skull which Brisebois had collected *in situ* 2.5 feet (0.8 m) above the gold-bearing gravel at this site.

On August 31, many bones (a number of them *in situ*) were collected at Kosuta's operation where 80 Pup enters Hunker Creek. Samples of droppings and grasses were collected from two rodent nests. M. Milner and R.E. Morlan gave me specimens of an arctic fox mandible and tibia, respectively, with a few other fossils they had collected at this site and John Erickson's. These are the first records of *Alopex lagopus* from the Dawson Area.

METHODS

Travel

Although Cessna 180 or De Havilland Beaver aircraft on floats were chartered occasionally from Dawson or Inuvik, I usually reached Old Crow by scheduled Douglas DC-3 or Fairchild F-27 flights from Whitehorse or Dawson. During the early stages of the project the DC-3s generally landed on a flat gravelly island a few miles up the Porcupine River from the settlement. Now there is an extensive landing strip at Old Crow.

From Old Crow, the main method of transport to various fossil localities in the area was river boat. The boats are long (approximately 9 m) and flat-bottomed, with upward-bevelled bows and square sterns made basically of plywood by a few skilled workers at Old Crow. They are capable of moving heavy loads (e.g. three or four people with three weeks of field rations, six 10 gallon (38 liter) kegs of fuel and camping and excavating equipment), and they have the advantage of shallow draft. Although a 12 hp engine was used to power the river boat during the first few field

seasons, I found a $9\frac{1}{2}$ hp Johnson outboard engine with short shaft to be more effective. It grounded less often, was lighter and more economical than the 12 hp engine and the slight loss of power was not found to be important. The quietness of the $9\frac{1}{2}$ hp engine was also advantageous when making notes on wildlife along the rivers. Fewer animals were scared away before they could be observed.

The rivers in the area rise and fall rapidly at times. Travel by boat was easier during the high water periods because the boat seldom had to be tracked through shallow patches of fast water. On the other hand, high water is a disadvantage from the paleontological viewpoint because some important, low-lying fossil localities are covered. In addition, bones that would otherwise have been exposed on the river banks or bars would not be observed.

Usually two or three boat trips lasting two or three weeks each were made during a field season at Old Crow. An interesting "balance effect" prevailed. As food and fuel were used, their weight-loss was replaced by fossils or other samples. On longer trips fuel or fossils were cached. Caches are placed high on the banks so that there is little danger of their being swept away by quickly rising water.

Where possible, camp sites are located fairly high on the relatively flat tops of sand or gravel bars. Solid gravel bars are preferable because less sediment is tracked or blown into the tent - particularly if the camp is used for a few days. Gravel and sand had an advantage over clay, in that during heavy rains the sites were not waterlogged: water percolated easily through the gravel or sand. Sometimes it is necessary to camp on higher terraces during very wet weather, or when the river is rising (the two do not always coincide). A continual watch must be kept on stream levels in the Old Crow Area for they can rise rapidly. Usually a peg was placed at the water's edge on arrival at a camp site and carefully monitored in order to predict danger to the camp site or as an indication whether or not low-lying fossil localities at other places on the river would be flooded. It is advisable to camp away from willows, if possible, for biting insects were most common near them. A good supply of insect repellant is necessary during the early part of the field season. After the first few frosts in August mosquitoes and black flies are not a problem.

Basic camping equipment for a party of three consists of: a Stormhaven tent (approximately 3.7 m x 2.1 m with 1 m walls) with floor, mosquito bar and extra stakes; a mountain tent (approximately 2.1 m x 1.5 m x 1 m) used for

caches or in emergency, a two-burner Coleman stove with extra generators and fuel funnels, three plastic pails for use in camp and alternating as containers for matrix when screening or for carrying larger fossils; two tarpaulins (2.4 m x 3 m) are useful for spreading bones and matrix on, and for covering material in the boat or caches. In the former case, a "covered wagon" section was arranged amidships using four curved willow saplings fastened into the gunwales on each side of the boat and lashed together by a few cross stringers above. It allowed easy access to the supplies and equipment while protecting them from rain. For shipment of equipment between Ottawa and the Yukon, and as strong containers for equipment, rations and sometimes fossils in the field, four medium-sized (63 cm x 43 cm x 25 cm) and one large (81 cm x 50 cm x 43 cm) expandable fibrecases with straps and handles (NVF Industries, Rexdale, Ontario) were handy.

Field work in the Dawson Area took place under quite different conditions. During the first three years I drove a National Museums of Canada Land Rover station wagon from Ottawa to Dawson. It was valuable because I wished to examine other fossil localities or potential localities on the prairies en route to the Yukon. In Dawson, motels or rented buildings were used for accommodation and storage. Most days would be spent in driving to various placer operations.

Occasionally I camped at some of the more remote localities. Because of the roughness of some of the roads and the unpredictable weather in late August, when most of the field work took place, it is advisable to have a 4-wheel-drive vehicle with two spare 6-ply tires and a heavy jack (e.g. "Jack-all"). An extra jerry can of gas and two tins of motor oil were usually carried on longer trips, such as those up the Dempster Highway.

Collecting

The western unglaciated part of the Yukon Territory, compared to most other parts of Canada that had been heavily glaciated, seemed to have great potential as a region for collecting ice age mammal remains. The literature since the beginning of this century suggested as much, as did reports of geologists who were familiar with the region, and who, in some cases, were able to pinpoint a few localities on the basis of previous field work.

The next step was to establish broad contacts with people living and working in the Old Crow and Dawson areas. Only the former area will be discussed.

In the Old Crow area, I was fortunate to start with

the assistance of Peter Lord, who knew many places along the Old Crow River where bones were likely to be found. Not only was he familiar with the river because of repeated journeys on it in the course of hunting and trapping, but he had helped to guide Otto Geist on his 1952 reconnaissance of the river for Pleistocene fossils.

Early trips in the Old Crow Area were aimed at covering as much ground as possible and noting the areas where bones were most abundant along the stream banks. The next step was to try to trace the bones back to their source beds. In some cases it was obvious that bones had slipped down from fossil-bearing sediment above their positions on the banks, and it was a matter of locating the source by climbing the banks until the organic layers were found. It soon became evident that the vertebrate fossils were commonly found in oxidized fine gravels or sands containing plant material such as wood, cones, peaty matter, and mollusc shells. As will be mentioned later, radiocarbon age information and the nature of the stratigraphy and fragmentary nature of the fossils at some localities where they were found "in place", usually indicated that the fossils were not in localities where the mammals they represented had died. It seems that primary sites might be found along the margins of the basin where sediments are being freshly cut by

major tributaries of the Old Crow River.

When a fossil locality is found it is plotted on a 1:250,000 scale topographic map (or more detailed maps as they become available) and given a number. The positions of the bones in relation to the level of the stream, the surface, or a stratigraphic marker horizon are indicated, and where possible, the bones are cursorily identified.

The main criterion used in selecting bones for the Quaternary Zoology Collection is that they have at least one and preferably more points of recognition (e.g. characteristic articular surfaces, protuberances or ridge for muscle attachment, foramina, or peculiar surface patterns such as the ribbing on the outer surface of giant beaver incisors and the prune-like wrinkling on wolverine canines). Usually limb bones are not kept unless a full articular surface is preserved. Rodent incisors were collected for a few years, but are no longer kept unless they are found in place where rodents have not been reported previously. Large bones like those of mammoths are not kept unless they are almost complete or belong to an articulated or partly articulated skeleton. Shipping costs from the Yukon to Ottawa are high. Occasionally poor but identifiable specimens are collected for radiocarbon dating.

Well-preserved fossils are picked up from the surface by walking along river banks at productive localities. The fossils are placed in collecting bags and later cleaned in river water using brushes with bristles of varying stiffness. Softer brushes are used on the smaller or more fragile specimens. Then the fossils are dried before being placed in cloth collecting bags on which the area, locality number, date and sometimes more detailed information are printed with a felt pen. When specimens seem to be of great importance (e.g. representing a rare species or artifacts) they are labelled directly with a field number such as "CR-74-35". The letters are collector's initials (CR), the next two digits indicate the year of collection (1974), and the next numbers specify the bone in a sequence of specimens collected in that year. The field numbers are then entered on the left page of a field notebook; the specimens are briefly described and sometimes sketched or photographed. The fossils are stored in bags or boxes in the boat, and after each trip are transferred to a storage building at Old Crow.

Excavations are usually undertaken at exposures where fossils are highly concentrated. They are first collected from the weathered surface, then, where overburden is not too thick, it is cut back using long-handled spoon shovels or by chopping it away with short folding spades. Depending upon

the size and fragility of the specimens, either the edge of a folding spade is used to scrape out sediment from the fossil layer, or excavations are conducted using a flat, sharp-tipped archeological trowel. Often the piles of excavated matrix were sluiced down with buckets of water to see if any valuable specimens had been missed. Sluicing was used most effectively at Old Crow Locality 29 where fossils happened to be concentrated in a thin oxidized gravel directly overlying a tough basal clay that sloped gradually down to the river like a ramp. Sluicing was facilitated because the site was at the water's edge.

Where microvertebrate (e.g. fish, bird or small mammal) remains are common, fossil-bearing sediments are trowelled through from top to bottom and then spread out on the surface behind the excavation. For this type of excavation it is important to have fairly direct sunlight on the deposit. In fact, I did not notice microvertebrate fossils in the sediments until a few weeks after I began collecting at Old Crow, when I chanced to be in a position where low sunlight illuminated the fossils in moist oxidized sands. The small bones were black and shiny in contrast to the matrix.

Excavations are halted when: (a) fossils become too

scarce; (b) permafrost is encountered (e.g. at Old Crow Localities 11(1), 20 and 44); (c) sandy overburden repeatedly covers the excavation; or (d) when steep clay or gravel banks show signs of collapsing. To counter some of these problems, it is occasionally possible to melt back permafrost by damming and diverting stream or creek water against the fossil-bearing exposures, or to wash them with water from a fire pump and hose. In some cases the deposits are left for a few weeks, allowing frozen sediments to thaw slightly. Where overburden is dangerous but not too thick (e.g. Old Crow Locality 29), it is levered down from above using spades. A fire pump (Wajax Mark 3, 4-stage high pressure centrifugal pump with frame) with 30 m of hose was used effectively at Old Crow Locality 10 to blast off the upper 1 m of muck and vegetation (including two birch trees), thus exposing a broad area of fossil-bearing sediments. Occasionally the pump was used to cut back sandy overburden or to clear slumped exposures for stratigraphic examination (e.g. Old Crow Locality 69).

Microvertebrate remains and large specimens are placed in small plastic boxes and plastic pails respectively. They are kept well back from the excavation where there is a danger of collapsing banks. To promote paleoenvironmental studies, collections of associated organic material, such as

plants (e.g. leaves, fruiting bodies, cones, bark and peat), mollusc shells, beetles and mammal droppings (e.g. moose pellets) are made and sealed in plastic bags or padded boxes. The bags are marked directly with a felt pen, and sticky labels (Denison Pres-a-Ply 52813) are applied to the plastic boxes and labelled using a ball-point pen. In some cases, series of pollen or ostracode samples are taken at regular intervals, in case they may shed some light on past environments or climates. The samples are collected from freshly cleaned exposures and are sealed in plastic bags. Volcanic ash samples are collected similarly. Sometimes a variety of pebbles is collected in plastic bags from a fossil-bearing gravel in order to obtain information on the source or sources of the gravel.

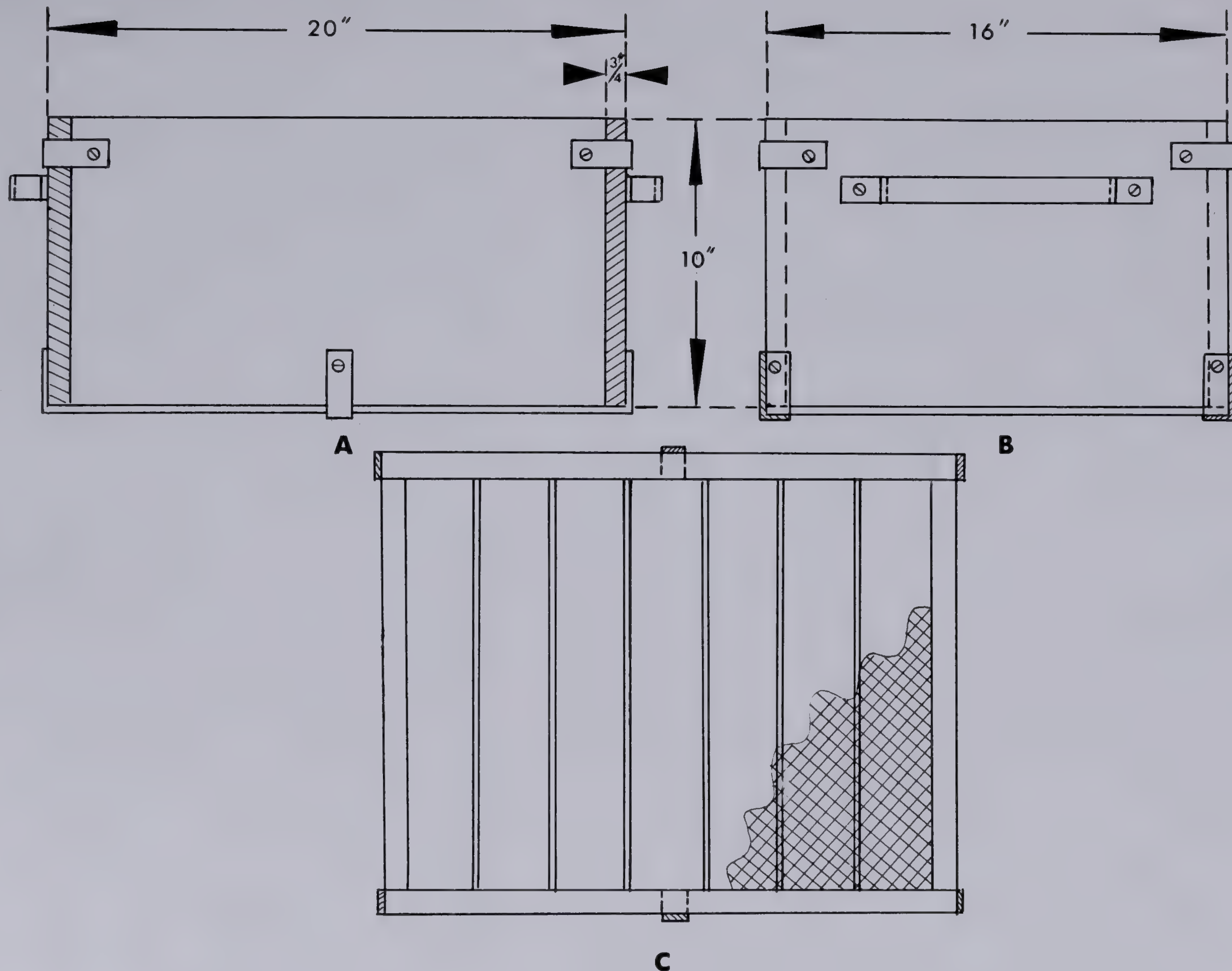
After a few day's collecting at a very productive site like Old Crow Locality 11A, the large bones are laid out on a tarpaulin to dry after cleaning. Then they are separated preliminarily according to genus and element and placed in cloth bags. Microvertebrates are washed and cleaned separately with soft brushes, dried on paper or tarpaulin and grouped under the following categories: fish, bird, rodent. They are laid in layers, according to taxon and skeletal element, on tissue in large plastic boxes. Layers are added until the box can be closed firmly without

the specimens shifting. This way many specimens can be kept separately in an economical, well-protected space.

At localities such as 27W and 44, which produced high concentrations of microvertebrate fossils, the matrix is wet-screened after the manner described by Hibbard (1949). As the screen had to be shipped between Ottawa and the Yukon, G.R. Fitzgerald constructed the parts separately, so that they could be packed flat in a field container and then bolted together when required (Figure 4). Small, tough clay balls resulted from screening matrix at Old Crow Locality 44 and made sorting difficult, whereas the cleaner sandy gravel from Old Crow Locality 27W allowed rapid sorting of fossils from the coarser fraction remaining on the screen.

Screening techniques have not yet been applied to any of the localities near Dawson. Screening is the next logical step in the collecting program there, particularly considering its effectiveness in the Fairbanks area of Alaska (Guthrie 1968a), which is similar stratigraphically and paleontologically to the Dawson Area (Harington 1970, p. 43). Furthermore, a potential site that has already produced microvertebrates is already known on Dominion Creek.

Figure 4. Plan showing construction of a collapsible wet-screen box for separating Pleistocene microvertebrate material from its surrounding matrix. A. Side view. Wood for frame is $\frac{3}{4}$ inch plywood. Star nuts hold rectangular metal corner brackets in place (no bolts project into the interior). B. End view. Metal handles are bolted on (nuts facing outside). C. Top view. Screen of hardware cloth (eight holes to the inch) is attached to the inside of the steel frame with epoxy glue and is supported on the underside by six metal bars welded across the frame. Flanges are welded to the steel frame so that it can be attached to the box.


20″
3/4
16″
10″
A
B
C

Stratigraphy

Exposures from which many fossils have been excavated, or which have yielded important specimens, or which seem to record a large or critical part of the Pleistocene geological history of the area, have been measured from river level to the surface. Generally I have used gross stratigraphic units like those of O.L. Hughes (Lichti-Federovich 1973, Figure 2) in the Old Crow Area. Our sections at Locality 44, made separately a few years apart, are very similar, for example. More detail has been recorded at localities like 22 and 14N in order to obtain a more precise idea of the sequence of deposition in constructional terraces over the past few thousand years.

Where sections can be climbed, generally an Abney level is used to record thicknesses of the various units. Sometimes the stratigraphic sections recorded include segments that are slightly offset so that information could be shown that would otherwise be obscured by slumped material. Occasionally fresh surfaces are cleared by spade or trowel in order to determine more precisely the unit boundaries (e.g. the buff silt - upper glaciolacustrine unit boundary at Old Crow Localities 12 and 15).

Horizontal relationships and orientations of fossils have been measured in a few cases (particularly in relation to the discovery of artifacts) by using a Brunton compass and tape (30 m Lufkin chrome clad). A 2 m tape (Lufkin chrome clad) was used to measure shorter distances.

Color, and black and white photographs (35 mm and 126 Instamatic) have been taken of the most important sections. Such photographs are usually supplemented by black and white Polaroid (101 Automatic) prints on which unit boundaries, descriptions and locations of fossils are marked directly in pen.

<u>Preserving, Cataloging and Curating of the Specimens</u>

Most Yukon Pleistocene mammal bones are solid in structure and present few problems as far as preservation is concerned. In fact, it is sometimes difficult to tell fossils from the Dawson Area, which yield dates between 20,000 and 30,000 years B.P., from modern bone. The former tend to be manila to tan rather than white in color. The same applies to late Wisconsin bison bones from Locality 11(1) in the Old Crow Area. Presumably their excellent preservation is at least partly attributable to burial in permafrost for most of the time since they were deposited. Even deeply stained bones from older ice age deposits in the

Old Crow Basin are quite durable. But there are exceptions.

Problems sometimes arise with mammoth bones, perhaps because of their large size and spongy interior. If such bones are found dry and are washed to clean off dirt adhering to them, they often make a fizzing sound and start to crack, presumably because silt inside expands on wetting and the strength of the surface bone is unable to withstand it. If this kind of breakage is suspected, it is usually better to try to remove the surface dirt with a stiff-bristled brush.

Mammoth teeth (including tusks) are notoriously difficult to preserve. The lamellar plates of the molars offer many vertical lines of weakness. Because they are composed of various, highly segregated materials (enamel, dentine and cementum) that apparently expand at different rates, they will crack vertically on drying after lying in a moist situation, or on wetting after having been in a dry condition. If sufficient time and care can be given to individual specimens that are moist, it is advisable to slow the rate of drying by wrapping them in moist cloths or burying them in moist sand and letting the sand and teeth dry slowly. Then tests can be made to see if preservatives can be applied. If no cracking occurs when preservative is

applied to small test areas on the tooth surface, then twine is wrapped around the molars and ring clamps (expandable stainless steel hose clamps) are tightened around the tusks before they are immersed for several days in a thin solution of polyvinyl acetate. Then they are allowed to dry. Supports are removed and any pieces of tooth adhering to the twine or clamps should be cemented in place. Surface cracks are then filled with polyester resin, plaster or epoxy. Finally the specimens may be coated with clear shellac.

Where breaks in fossils are noted during field work, the pieces are glued together directly and placed in a protected container. Or, if the breakage is complex, the pieces are temporarily packaged together and repaired after the bones are washed, dried and ready for packing. Some are left for later repair in the laboratory. In order to preserve bones most satisfactorily in the cloth sample bags, usually the heaviest, most durable specimens are placed at the bottom, tough limb bones are placed around the outside like splints, and the more fragile bones are wrapped in tissue, put in plastic bags and placed near the upper central part of the bags. As noted previously, microvertebrate remains are cleaned, dried and placed systematically in padded, labelled plastic boxes. At the end of the field

season the most important specimens are well packed and taken as personal luggage from the Yukon to Ottawa. The field sample bags are packed in wooden or strong cardboard boxes or fibrecases, padded with paper and carefully tied around all surfaces with clothesline rope.

When the bones are received in the laboratory in Ottawa, they are given a final cleaning. Broken bones are glued together using household cement for smaller breaks and epoxy for breaks needing extra strong bonding. A thin, penetrating coat of Gelva (Gelva V-15, a preservative produced by Monsanto Canada Ltd. which is thinned with alcohol or acetone) is applied by brush to bones with damaged or cracked surfaces, and progressively thicker coats are applied until the bone is sufficiently hard. Most of the ice age mammal specimens from the Yukon do not require this treatment.

Bones are then labelled by painting 3 mm x 2 mm patches of white auto enamel in unobtrusive places on each. Care is taken to avoid covering tooth surfaces or foramina. On each patch the NMC catalog number, the district (Y.T. for Yukon Territory), the area (e.g. Old Crow River) the locality number, and date of collection are printed in black drawing ink (Pelikan 17 black) with a rapidograph pen (No. 1 Koh-I-Noor). On smaller bones only the NMC numbers are printed. Then a sealer coat of Gelva is brushed

over each label and allowed to dry. Catalog cards and separate 8 cm x 4.5 cm cards to be placed with each specimen are filled in. The latter provide the following data: catalog number, accession number, scientific name, skeletal element represented, locality, collector(s), date of collection and identifier's name. Identifications and identifier's name are in pencil; the remaining data are in ink.

The fossils are filed in trays in metal cabinets (Model 301-RD Geology-Paleontology specimen cabinets supplied by Lane Science Equipment Corporation, New York) organized by: (a) district (e.g. Yukon Territory) - Old Crow and Dawson area collections are separated for convenience; (b) taxa (in the order given by Simpson (1945)); and (c) skeletal element (Table 4). Where possible, bones from the right side are separated from those of the left.

The largest specimens, such as mammoth limb bones and bison skulls, are organized on open steel racks near the back of the laboratory. Large bones, such as horse limb bones, are filed in trays padded with "Air Cap", which prevents damage and checks rolling and sliding of specimens when trays are moved. Intermediate sized specimens are placed in open cardboard trays. Rare or fairly complete

Table 4. Organization of Yukon Quaternary mammal fossils in cabinets according to skeletal elements.

Skull	1.	Cranial elements and upper teeth (including horncores and horn-sheaths).
	2.	Mandibles and lower teeth.
Axial Skeleton	3.	Vertebrae: (a) cervical. (b) thoracic. (c) lumbar. (d) sacral. (e) caudal.
	4.	Ribs.
Forelimb	5.	Scapulae.
	6.	Humeri.
	7.	Radii and ulnae.
	8.	Carpals and sesamoids.
	9.	Metacarpals.
	10.	Phalanges.
Hindlimb	11.	Pelves.
	12.	Femora.
	13.	Tibiae and fibulae.
	14.	Tarsals, sesamoids and patellae.
	15.	Metatarsals.
	16.	Phalanges.

specimens of medium to small size are packed in clear plastic boxes with snap lids. Pads of cotton wool are placed below them and the specimen cards laid below the pads facing down, so that they can be read instantly by turning the box over or lifting it up. For example, specimens the size of a wolf maxilla fragment, a fox mandible, and a marten mandible are stored in plastic boxes of the following dimensions, respectively: 12 cm x 9 cm x 4 cm; 7 cm x 5 cm x 3 cm; and 5.5 cm x 5.5 cm x 2.3 cm. The smallest specimens, such as rodent jaws and limb bones, are placed in 5.5 cm x 1 cm (diameter) glass vials, which are glued to the back of the specimen card. The ends of the vials are padded with cotton wool to prevent damage. The cards stop the vials from rolling around in the trays and provide a ready source of information. The "card vials" are then placed with the card up in cardboard trays according to taxon and elements, and the cardboard trays are filed in the metal cabinet trays.

Skeletal Measurements

Measurements taken usually follow those used in current or standard reviews of the particular taxa concerned, in order to facilitate comparisons. Where fossils of existing species are concerned, it is difficult to

duplicate the numerous measurements taken by mammalogists, because fossils are usually incomplete. In such cases, a few particular measurements are taken, and recognizing the limitations of this method, they are compared with the same measurements of the appropriate Pleistocene or Recent mammal specimens. Care is taken to note where original measurements were larger, or where measurements are estimated or approximate. Except where fossils are considered to be of critical importance despite their condition, generally only the more complete specimens in the collection have been measured. Statistical summaries and comparisons of skeletal elements of the species of Yukon Pleistocene mammals will be left until the scheduled close of the project in 1985, when more data will be available.

The largest specimens, such as mammoth limb bones or bison crania, are measured with a pair of metal claw calipres (Starrett; Atholl, Massachusetts) with a span of about 1.2 m used in conjunction with a 2 m chrome clad tape. For more precise large measurements a pair of 75 cm Mitutoyo vernier calipres are used. Medium-sized fossils are measured with 32 cm Carl Mahr vernier calipres. Small fossils are measured with Mitutoyo 20 cm dial calipres.

For measuring, identifying and photographing microvertebrate specimens a Tessovar Photomacrographic Zoom

System (Carl Zeiss) was found to be excellent. Illumination, which is operated by a transformer, is good, and the zoom lens allows the detailed focussing necessary for the study of rodent teeth. An automatic 35 mm (C-35-M) camera is attached.

Radiocarbon dates

In order to get an indication of the age of various species of Pleistocene mammals in the unglaciated part of the Yukon, a series of more than 20 radiocarbon analyses were obtained form Teledyne Isotopes (Westwood, New Jersey) by the Quaternary Zoology Section of the National Museum of Natural Sciences. It was hoped that the dates would provide evidence concerning the times and patterns of extinction of some of the ice age mammals in Eastern Beringia. Occasionally this series of radiocarbon dates has been supplemented by those obtained through the Geological Survey of Canada and Geochron. Except for the dates from Geochron, which involved analyses of bone apatite, all are based on bone collagen fractions of mammal fossils. These data are limited to approximately the last 50,000 years. Some Yukon fossils have yielded infinite radiocarbon dates, which are often greater than 39,000 years B.P. Radiocarbon dates referring to Yukon and Alaskan Pleistocene mammals are included in Tables 5 and 6 respectively.

In a few cases, casts are made of the original

Table 5. Radiocarbon dates on bone from Yukon Pleistocene mammals.*

SPECIES	RADIOCARBON DATE (years before present (1950))	LABORATORY NUMBER	MATERIAL	LOCALITY	REMARKS
Mammuthus sp. (mammoth)	16,000 ± 130	GSC-1893	Tusk	Scroggie Ck. Loc. 1	Collected by Bostock from ground surface near a muck bank cut by a stream.
" "	22,600 ± 600	I-3573	Femur	Old Crow Loc. 14N	
" "	25,700 +1800 −1500	GX-1568	Long bone shaft	Old Crow Loc. 14N	Fractured by heavy blows when fresh. Artifact. Bone apatite date.
" "	29,100 +3000 −2000	GX-1567	Radius	Old Crow Loc. 14N	Flakes removed from shaft when fresh. Bone apatite date.
Mammuthus primigenius (woolly mammoth)	30,300 ± 2000	I-3576	Ribs	Whitestone Loc. 43	From an individual mammoth. Many semi-articulated elements were excavated.
Mammuthus sp. (mammoth)	32,250 ± 1750	I-4226	Thoracic vertebra	Dawson Loc. 32	From Schink and Lamontagne's placer operation.
" "	> 39,900	I-4228	Thoracic vertebra	Old Crow Loc. 44	Excavated from fossiliferous unit above basal clay unit.
Equus (Asinus) lambei (Yukon wild ass)	14,870 ± 260	I-3569	Metacarpal	Dawson Loc. 28	Excavated from interface of muck and gold-bearing gravel.
Equus sp. (horse)	34,000 ± 2600	I-4222	Metatarsal	Old Crow Loc. 28	Appears to represent a large horse.
" "	> 39,900	I-4223	Pelvis	Old Crow Loc. 44	Appears to represent a large horse. Excavated from fossiliferous unit above basal clay unit.
Cervus elaphus (wapiti)	4,570 ± 100	I-4225	Humerus shaft	Old Crow Loc. 1	Faceted on distal ends, which are preserved.
Alces latifrons (giant moose)	33,800 ± 2000	I-4229	Antler beam	Old Crow Loc. 22	Excavated from gravels from a constructional terrace.
Rangifer tarandus (caribou)	5,010 ± 100	I-8642	Radio-ulna	Dawson, Loc. 8	Excavated from a blackish vegetative layer above gravel.
" "	6,450 ± 135	I-4221	Antler	Old Crow Loc. 69	
" "	23,900 ± 470	I-8580	Antler	Dawson Loc. 16	Most of antler preserved in NMC collection. From Erickson's placer operation.
" "	27,000 ± 3000 2000	GX-1640	Tibia	Old Crow Loc. 14N	Fleshing tool with serrated edge. "Blade" is preserved. Bone apatite date.
Bison bison athabascae (wood bison)	1,350 ± 95	I-5404	Frontal	Dawson Loc. 6	Right horncore preserved. From Schmidt's placer operation.
Bison crassicornis (large-horned bison)	11,910 ± 180	I-7765	Scapula	Old Crow Loc. 11(1)	From late Wisconsin fossil bison site.
" "	12,275 ± 180	I-7764	Horncore	Old Crow Loc. 11(A)	Found on surface of bar. Presumably derived from Loc. 11(1) a short distance upstream.
" "	12,460 ± 220	I-3574	Lumbar vertebra	Old Crow Loc. 11(1)	From late Wisconsin fossil bison site.
" "	22,200 ± 1400	I-3570	Horncore	Dawson Loc. 32	From Schink and Lamontagne's placer operation.
" "	24,900 ± 1000	I-3575	Horncore and frontal	Dawson Loc. 25	From Strachan's placer operation on a bench above the Klondike River.
" "	30,300 ± 1850	I-3571	Horncore	Dawson Loc. 7	From Sailer's placer operation.
" "	33,800 ± 2000	I-4227	Humerus	Old Crow Loc. 14N	Evidently from a large bison, like *B. crassicornis*.
Bison alaskensis (Alaskan bison)	> 39,900	I-5405	Frontal and occipital	Dawson Loc. 32	Most of left horncore preserved. From Schink and Lamontagne's placer operation.
Ovibos moschatus (muskox)	2,830 ± 100	I-3568	Horncore	Brewer Loc. 1	From near the surface at Djukestein's placer operation.
Ovis dalli (Dall sheep)	23,000 ± 600	I-4225	Horncore	Dawson Loc. 2	From Heitman's placer operation.

* All radiocarbon analyses have been on bone collagen, unless otherwise indicated.

Table 6. Radiocarbon dates referring to Alaskan Pleistocene mammals. (Mainly after Péwé 1975a, Table 13).

SPECIES	RADIOCARBON DATE (years before present (1950))	LABORATORY NUMBER	MATERIAL	LOCALITY	REMARKS
Spermophilus parryi (ground squirrel)	14,510 ± 450	W-2703	Ground squirrel droppings	Chatanika River, (right limit)	From about 1.5 m above Chatanika Ash Bed.
" "	14,760 ± 850	GX-0250	Ground squirrel nest.	Chatanika River, (right limit)	From about 2 m below Chatanika Ash Bed.
Castoridae (probably *Castor canadensis*)	3,700 ± 150	L- 434	Beaver-gnawed wood	Cook Inlet area (Third Bay)	From beneath a 5 to 9-foot (1.5 to 2.7 m) thick peat unit.
Castor canadensis	6,730 ± 260	W-1108	Beaver-gnawed wood	Tofty area (Sullivan Ck.)	In peaty silt about 2 m below surface at Sullivan placer operation. Possibly reworked.
" "	6,820 ± 200	W- 733	Large beaver-gnawed log	Tofty area (Sullivan Ck.)	From dam covered by 5 feet (1.5 m) of yellow silt.
" "	9,330 ± 300	W-2160	Beaver-gnawed wood	Kotzebue area (Washington Ck.)	From dam at base of 8-foot (2.4 m) thick silt unit overlying gold-bearing gravel.
Panthera leo atrox (American lion)	22,680 ± 300	SI- 456	Tendon from left tibia	Fairbanks area (Upper Ester Ck.)	From frozen muck.
Mammuthus primigenius (woolly mammoth)	15,380 ± 300	SI- 453	Flesh from lower leg	Fairbanks area (Fairbanks Ck.)	From frozen muck.
Mammuthus sp. (mammoth)	?21,300 ± 1300	L- 601	Skin and flesh of baby mammoth	Fairbanks area (Fairbanks Ck.)	Associated with gravel stringers and a beaver dam. Date seems reasonable, but may be invalid as hide was evidently soaked in glycerine by collector.
" "	32,700 ± 980	ST-1632	Hair from mammoth skull	Fairbanks area (Dome Ck.)	From frozen muck.
Equus sp. (horse)	15,750 ± 350	K-1210	Right scapula	Kotzebue area (Trail Ck.)	From lower clay layer outside entrance at Cave 9.
" "	26,760 ± 300	SI- 355	Bone	Lost Chicken Ck.	From frozen muck.
Camelops sp. (extinct camelid)	24,900 ± 1100/1000	I-2117	Metapodial	?Fairbanks area	Personal communication J.V. Matthews, Jr. 1975.
"*Bison (Bison) preoccidentalis*" (type specimen)	11,735 ± 130	ST-1631	Piece of hornsheath	Fairbanks area (Upper Cleary Ck.)	From frozen muck. Possibly a female of *Bison crassicornis* ?
Bison crassicornis (large-horned bison)	11,980 ± 135	ST-1633	Hide	Fairbanks area (Fairbanks Ck.)	From frozen muck.
"*Bison (Bison) preoccidentalis*" (type specimen)	12,460 ± 320	SI- 290	Pieces of hornsheath	Fairbanks area (Upper Cleary Ck.)	From frozen muck. Compare to date ST-1631 on the same specimen.
Bison sp.	13,070 ± 280	K-1327	Bison calcaneum	Kotzebue area (Trail Ck.)	From lower clay layer outside Cave 9. Cracked by man.
Bison crassicornis	16,400 ± 2000	M- 38	Hornsheath	Fairbanks area (unknown creek)	From frozen muck.
Bison sp.	17,170 ± 840	SI- 838	Hornsheath	Fairbanks area (Fairbanks Ck.)	From frozen silt.
" "	18,000 ± *200	SI- 841	Hornsheath	Tanana area (near Manley Hot Springs)	From frozen silt.
" "	20,445 ± 885	SI- 837	Hornsheath	Fairbanks area (Fairbanks Ck.)	From frozen silt.
" "	21,065 ± 1365	SI- 839	Hornsheath	Fairbanks area (Cripple Ck.)	From frozen silt.
Bison crassicornis	> 28,000	L- 127	Dried tissue from carcass	Fairbanks area (Dome Ck.)	From frozen silt in contact with gold-bearing gravel.
Bison sp.	29,295 ± 2440	SI- 842	Hornsheath	Fairbanks area (Cripple Ck.)	From frozen silt.
Bison crassicornis	31,400 + 2040 / - 1815	ST-1721	Hide and hair from carcass	Fairbanks area (Dome Ck.)	From frozen silt in contact with gold-bearing gravel. (From same carcass as L-127).
"*Bison preoccidentalis*"	31,980 ± 4490	SI- 843	Hornsheath	Fairbanks area (unknown creek)	From frozen silt. Possibly a female of *Bison crassicornis*?.
Bison sp.	> 35,000	SI- 844	Hornsheath	Fairbanks area (Little Eldorado Ck.)	From frozen silt.
Bison sp.	> 39,000	SI- 840	Hornsheath	Fairbanks area (Cripple Ck.)	From frozen silt.
Ovibovini (muskoxen) (*Boötherium*?)	17,210 ± 500	SI- 454	Hair from hind limb of muskox carcass	Fairbanks area (Fairbanks Ck.)	From frozen silt.
" "	24,140 ± 2200	SI- 455	Muscle from scalp of muskox carcass	Fairbanks area (Fairbanks Ck.)	From frozen silt. From same specimen as SI-454.
Boötherium sargenti ("*Boötherium nivicolens*")	22,540 ± 900	SI- 292	Hornsheath	Fairbanks area (Fairbanks Ck.)	From frozen silt.
Symbos cavifrons	17,695 ± 445	SI- 851	Hornsheath	Fairbanks area (Dome Ck.)	From frozen muck.
" "	25,090 ± 1070	SI- 850	Hornsheath	Fairbanks area (Upper Cleary Ck.)	From frozen muck.
Symbos cavifrons ("*Symbos giganteus*")	> 40,000	SI- 291	Winter droppings (pellets) associated with skeleton and hair	Fairbanks area (Little Eldorado Ck.)	From frozen muck.

specimens before they are sacrificed for dating, and a file of photographs, measurements and notes are kept on them. Where bone is left after analyses, it has been returned. In this way, diagnostic parts which are still useful as specimens can be retained in the collection, or excess bone may be available in sufficient quantity to provide a check date from another laboratory. Very small samples insufficient for radiocarbon dating are kept in the hope that new techniques of dating requiring smaller amounts of bone will be developed in the future. The amino acid racemization technique being developed by Bada (Anonymous 1975, p. 349) seems to have potential in this respect.

In a number of cases radiocarbon dates have been received on organic material other than bone, where it had some bearing on the age of Pleistocene mammals or on changing Pleistocene environments in the field areas. Thus analyses have been carried out on mollusc shells, wood, peaty material and plant detritus (Table 7). Of particular interest are the two analyses on freshwater clam *(Anodonta beringiana)* shells from different sites in the Old Crow Basin, both of which have yielded dates of about 10,800 years B.P., indicating the period of major postglacial downcutting. A piece of wood from the fossil-bearing unit at Old Crow Locality 44 provided a minimum age of more than 54,000 years B.P. for the Pleistocene fauna represented in

Table 7. Radiocarbon dates on organic material other than bone from the Old Crow, Dawson and Donjek areas, Yukon Territory.

SPECIMEN IDENTIFICATION	RADIOCARBON DATE (years before present (1950))	LABORATORY NUMBER	LOCALITY	REMARKS
Freshwater Mollusc Remains				
Anodonta beringiana (shells of fresh-water clams)	10,850 ± 160	I-4224	Old Crow Loc. 69	Evidently dates maximum downcutting of Old Crow River after late Wisconsin glacial lake was drained.
" "	10,700 ± 160	GSC-1167	Old Crow Loc. 141	Excavated. Well preserved. As above.
Mainly *Pisidium idahoense* (shells of small molluscs)	32,400 ± 770	GSC- 952	Porcupine Loc. 100	Unreworked shell from a layer about 5 to 8 ft. (1.5 to 2.4 m) below late Wisconsin glacial lake deposits. Dates grayling (*Thymallus arcticus*) and lemming (*Lemmus sibiricus*) remains.
Plant Remains				
Salix sp. (willow wood)	> 42,000	GSC-1297	Old Crow Loc. 12	From unit overlying basal clay unit, sample from about 5 ft. (1.5 m) below base of late Wisconsin glacial lake deposits.
Unidentified wood (small twigs and branches)	14,390 ± 160	GSC- 730-2	Old Crow Loc. 14N	Excavated from point bar deposits estimated to be a few thousand years old. Wood is probably of mixed ages.
Unidentified wood (large piece 24 cm. in diameter)	41,280 ± 1600	GSC- 730	Old Crow Loc. 14N	Excavated from point bar deposits estimated to be a few thousand years old.
Organic detritus	7,620 ± 160	GSC-1252	Old Crow Loc. 15	From near base of postglacial peat unit.
Organic detritus	1,740 ± 100	I-2756	Old Crow Loc. 22	From organic layer in a constructional terrace 13 ft. (4.0 m) above basal clay unit and 16 ft. (4.9 m) below the surface.
Unidentified wood	2,420 ± 80	I-2755	Old Crow Loc. 22	From oxidized sandy gravel unit producing mammal fossils which overlies basal clay unit.
Unspecified organic matter	6,430 ± 140	GSC- 372	Old Crow Loc. 32	From postglacial peat unit (about 6 ft. (1.8 m) below surface).
Wood	7,650 ± 150	GSC-1175	Old Crow Loc. 32	From postglacial peat unit (about 20 ft. (6.1 m) below surface).
Peat	8,100 ± 160	GSC-1243	Old Crow Loc. 32	From postglacial peat unit (about 25 ft. (7.6 m) below surface).
Organic detritus	31,300 ± 640	GSC-1191	Old Crow Loc. 32	From unit overlying basal clay unit, sample from about 5 ft. (1.5 m) below base of late Wisconsin glacial lake deposits.
Populus sp. (poplar or aspen wood)	8,270 ± 140	GSC-1329	Old Crow Loc. 44	Minimum date for formation of postglacial peat.
Unidentified wood (part of a log)	> 39,900	I-3572	Old Crow Loc. 44	Excavated from fossil-bearing unit above basal clay.
Picea sp. (spruce wood)	> 44,000	GSC-1593	Old Crow Loc. 44	From fossil-bearing unit above basal clay unit.
Picea sp. (spruce) (stick 26 cm. long)	> 54,000	GSC-2066	Old Crow Loc. 44	From fossil-bearing unit above basal clay. Suggests fossil-bearing unit could be of Sangamon interglacial age.
Picea sp. (spruce wood)	> 42,000	GSC-1589	Old Crow Loc. 88	From unit overlying basal clay unit.
Peat	10,740 ± 180	GSC- 121	Porcupine Loc. 100	Dates beginning of peat formation after drainage of late Wisconsin glacial lake.
Unidentified wood (two large pieces)	> 37,000	GSC- 958	Porcupine Loc. 100	Possibly reworked and therefore older than the layer in which it was found. See freshwater mollusc shell date GSC-952.
Wood	> 41,300	GSC- 199	Porcupine Loc. 100	Indicates deposition of silt and sand (Unit 5 of Hughes (1969 p. 210)) began more than 41,300 years ago.
Populus sp. (poplar or aspen) (Stick 27 cm. long)	9,040 ± 140	GSC-1454	White River (across from Donjek)	*Bison* cf. *crassicornis* collected with this wood about 30 ft. (9.1 m) above the base of a 54-foot thick (16.5 m) organic silt unit which was dated at >38,000 years B.P. Date seems too recent.
Peat	9,510 ± 220	GSC- 196	Dawson Loc. 12	From silty peat layer 10 ft. (3.0 m) below the surface of the muck at Fant and Norback placer site (Unit 5, see below). Pleistocene mammals lay below this unit.
Picea sp. (spruce wood)	> 35,000	GSC- 181	Dawson Loc. 12	Provides a minimum date for mud overlying gold-bearing gravel (Unit 2 of O.L. Hughes (see Hunter and Langston 1965, p. 675)) at Fant and Norback placer site. Possibly mammal bones derived from above this unit.

it. Furthermore, radiocarbon dates on sticks from Locality 14N first alerted me to the fact that the fossiliferous zone at the site contained organic material of greatly varying ages. The reason for this phenomenon was then sought.

Because the cost for radiocarbon analysis of a single specimen is currently about $160, samples for dating are chosen with care. First the specimen must be free from organic preservatives (e.g. polyvinyl acetate, Gelva, Glyptal, Alvar, etc.) or deeply penetrating rootlets or other organic material that would destroy the validity of the date. I have usually kept the dried specimens in aluminum foil, bags or boxes until they are submitted. Each specimen is cleaned with water before it is sent to the laboratory.

The radiocarbon dates are of greater significance if the specimens to be analyzed can be identified to species. Then it is possible to arrive at certain conclusions concerning the evolutionary history or time of extinction of a species. I have avoided submitting very good specimens, such as skulls, for radiocarbon analysis because of their primary value in the collection. Exceptions exist, however (e.g. the caribou fleshing tool from Old Crow Locality 14N). Where species are rare and specimens are small, as in the

short-faced bear, giant beaver, ground sloth or camel, no attempt has been made to radiocarbon date them.

Does the fact that ice age mammal bones have been enclosed in permafrost for long periods affect the validity of radiocarbon dates they yield? James Buckley of Teledyne Isotopes advised that he knew of no way that cold temperatures could influence radioisotopic breakdown rates. He stated that bacterial action was one of the main factors to consider in destroying the validity of radiocarbon dates, and he suggested that the freezing permafrost environment would be ideal for preserving bone for reliable radiocarbon dating. James A. Lowdon of the Geological Survey of Canada Radiocarbon Dating Laboratory replied similarly. He suggested that bone from permafrost areas would be more reliable to radiocarbon date than bone that has had the chance of being contaminated by humic acid.

The method of analysis used by Teledyne Isotopes for radiocarbon dating bone submitted by the Quaternary Zoology Section is as follows. Bone was processed according to the method of Berger *et al.* (1964, p. 999) and subsequently modified by C.V. Haynes. The modification involves treating the collagen with a dilute sodium hydroxide solution to remove the possibility of humic acid contamination. Bone

analyzed by the Geological Survey of Canada Radiocarbon Dating Laboratory is pretreated with hydrochloric acid and sodium hydroxide. More details concerning this laboratory and the techniques used there are provided by Dyck (1967).

STRATIGRAPHIC AND PALEOENVIRONMENTAL BACKGROUND

Before describing mammal remains found in Yukon Pleistocene deposits, it seems appropriate to comment on their source beds in the sedimentary sequence, the possible ages and relationships of these deposits, and on the characteristics of the environments in which the mammals lived, as far as can be determined by fossils and the nature of the deposits themselves. Only a few of the more important localities in the unglaciated parts of the Yukon Territory and Alaska will be mentioned. The sites are chosen on the basis of the relative completeness of the Pleistocene record exposed, and on the degree of information available at each.

Old Crow Area

Porcupine River (Locality 100) -

This locality is of key importance to Pleistocene geological and paleoenvironmental studies in the Old Crow Area. It is situated about 9 miles (15 km) downstream from

the settlement of Old Crow on the left limit of a large bend in the Porcupine River. The stratigraphy of this approximately 200-foot (61 m) high bluff has been described by Hughes (1969, p. 210; 1972, p. 8) and in slightly revised form by Lichti-Federovich (1974, p. 5) in consultation with Hughes. My interpretation of the sequence of deposits is largely based on their data, but is supplemented by observations resulting from several personal collecting trips to the locality during the 1966 - 1973 period. The section is described in geochronological sequence from bottom to top.

Lichti-Federovich (1974, p. 5) observed that all pollen assemblages recorded here and along the Old Crow River lack significant amounts of Tertiary pollen types, and suggested that the oldest unit at Locality 100 (pollen assemblage type Va) is of mid- or early Quaternary age.

Unit 1 consists of deltaic, lacustrine and fluvial sediments. The lower subunit is composed of reddish, partly cemented, oxidized grit with silt lenses containing many large spruce logs and cones. The latter are intermediate in size between those of modern white spruce *(Picea glauca)* and the extinct *Picea banksii* discovered by L.V. Hills (Hills and Ogilvie 1970) in upper Miocene deposits (Beaufort Formation) on northern Banks Island.

No vertebrate fossils have been found in place in the unit, although I have examined it carefully in successive years. However, indirect evidence of the presence of beavers is provided by a long, highly-compressed lens of beaver-cut sticks, which I (Harington 1971a, p. 80) tentatively interpreted to be part of a dam. These facts suggesting that boreal forest with standing water and streams formerly existed in the area are corroborated by pollen data (Lichti-Federovich 1974, p. 4). Birch, pine and spruce were common. Alder was locally common, and hazel occurred sporadically. The presence of hazel is significant because it is now confined to the southern fringes of the boreal forest and is most abundant in the aspen parkland and deciduous forest zone. At the time this unit was deposited, probably the area was drained by streams that flowed eastward through the Richardson Mountains at McDougall Pass (Hughes 1969, p. 211).

Hughes (1972, p. 7) states: "The large logs in Unit 1 suggest a climate at least as warm as that of today, in which white spruce to 15 inches {38.1 cm} diameter are common on the Porcupine flood plain and a few trees even attain 20 inches {51 cm} diameter." Thus an interglacial climate is implied. Lichti-Federovich (1974, p. 4) suggests that Unit 1 is of "pre-Wisconsin (?Sangamon) interglacial"

age. On the basis of rates of sedimentation (calculated according to radiocarbon dates and sediment thicknesses in the upper part of the section, extrapolated downward in the section), the abundant large logs and flattened wood, the apparent primitive nature of the spruce cones, the degree of induration of the red grit, and the recapitulation of glaciolacustrine units higher in the section (which I tentatively consider were deposited during glacial maxima), I (Harington 1971a, p. 80) speculated that this deposit is interglacial, and of Yarmouth age or perhaps older. At present, there seems to be no reason for changing this view.

The upper 4 feet (1.2 m) of the unit are convoluted due to frost action. This seems to indicate the onset of a glaciation resulting in the formation of a deep, cold glacial lake, which is demonstrated by the thick glacio-lacustrine deposits which overlie Unit 1.

Unit 2 consists of the lower glaciolacustrine sediments which, according to Hughes (1972, p. 7), were laid down when Laurentide ice advanced westward against the Richardson Mountains blocking eastward drainage through McDougall Pass, forming a vast cold lake that discharged westward at what is now known as The Ramparts. The cold, biologically arid nature of this early glacial lake is

indicated by the virtual absence of ostracodes in this unit as noted by Delorme (Hughes 1969, p. 209). I wish to point out the similarity of this unit with the basal clay unit on Old Crow River. Both are significantly jointed with oxidized joint surfaces, both are gray when moist and brownish when dry, and both contain organic detritus and ironstone concretions (noted by O.L. Hughes in his section at Locality 100 made on July 2, 1970, a copy of which is in my files).

Pollen in this unit is similar to that of Unit 1, but it lacks hazel pollen and it is rich in pollen of herbaceous plants and bryophytes - perhaps indicative of cooler climatic conditions.

Hughes (1969, p. 212) believes that this glacial lake stage is probably of "pre-classical Wisconsin or older age". Lichti-Federovich (1974, p. 4) gives its age as "Early Wisconsin Glaciation". I suggest that the glacio-lacustrine sediments were laid down during the maximum of the Illinoian glaciation. The fact that this lower glacio-lacustrine unit is much thicker than the upper glacio-lacustrine unit (Unit 5) formed during the peak of the Wisconsin glaciation (i.e. during the late or classical Wisconsin), may be indicative of the relatively greater

severity and longer duration of the Illinoian glaciation. Perhaps Laurentide ice did not penetrate far enough westward to block McDougall Pass during early Wisconsin time.

Unit 3 consists of lenses of gravel, twigs and wood which I think are of Sangamon interglacial age. In contrast to Hughes (Lichti-Federovich 1974, p. 5), who makes this a lower subunit of a thicker mass of deltaic, lacustrine and fluvial sediments, I prefer to regard it as a separate unit. Wood from near the top of this unit yielded a radiocarbon date of more than 41,300 years B.P. (GSC-199).

Pollen evidence suggests that boreal forest conditions gave way to a tundra landscape after the deposition of this unit had commenced, which could also imply that the unit is, at least in part, Sangamon. But there is a difficulty involved in comparing two sections made by Hughes, the first with radiocarbon dates in 1968, the second with pollen samples in 1970 (Lichti-Federovich 1974, Figure 2).

Convolutions in the upper 3 to 4 feet (0.9 to 1.2 m) of Unit 3 may have resulted from frost action occurring at the onset of the Wisconsin glaciation.

Unit 4 is composed of thick brownish silts, much like those of the upper part of Unit 2 and Unit 3 at Old Crow Locality 44. The sediments appear to have been laid down mainly under lake and delta conditions.

Grass, sedge and herb communities were dominant according to analyses of pollen samples from the unit. There is a preponderance of pollen of grasses and sedges (50-70%), with lesser quantities of birch (5-30%), spruce (1-15%) and willow (1-5%) pollen.

A shell-rich layer about 3 feet (1.5 m) from the top of the unit yielded a radiocarbon date of 32,400 ± 770 years B.P. (GSC-952), which indicates its Wisconsin age. Presumably the material from this shell-zone was deposited during the early part of a mid- Wisconsin interstadial that would correlate best with the Karginsky interstadial of Siberia (Kind 1967, p. 181) and the Olympia Interglaciation of southwestern British Columbia and northwestern Washington (Armstrong *et al.* 1965). This layer has been called the "*Cytherissa lacustris* zone" because Delorme (1968) found a great preponderance of this species of ostracode in samples from it. Perhaps a better name would be the "*Pisidium idahoense* - *Cytherissa lacustris* zone", because the former species of small freshwater mollusc is the main visible indicator of the layer. I (McAllister and Harington 1969,

p. 1189) have suggested that this zone may correlate with the extensive late Pleistocene Gubik Formation of northern Alaska, which lies at similar depth and is characterized by *Cytherissa lacustris* (Swain 1963). It could be a useful marker horizon for Wisconsin deposits of northern Alaska and the Yukon.

In addition to plant, insect, ostracode and mollusc fossils, scales of grayling *(Thymallus arcticus)* and remains of brown lemming *(Lemmus sibiricus)* were collected and identified from this zone (Table 8). Preliminary paleo-environmental interpretation (McAllister and Harington 1969, p. 1188-1189) based on limited data (particularly where seeds and insects are concerned) suggests the former presence of a large, cool, shallow lake with a mud bottom and *Potamogeton* near its margin. Wet meadow habitat was nearby. Spruce trees and herbaceous plants probably occupied drier areas in the region. A more precise paleo-environmental description of the zone is provided by Matthews (1975). He notes the large numbers of tundra-adapted insects and plants among the fossils (Table 8): 40% obligate tundra, 55% forest and tundra, 5% obligate forest. As several of the insects are flightless, tundra-dwelling carabid bettles, their presence means that tundra communities were located near the Porcupine site and that treeline

Table 8. List of animal and plant fossils of mid-Wisconsin (34,200 ± 770 years B.P.) age from Porcupine River Locality 100*.

Animals

Vertebrates

Mammals

Lemmus sibiricus (brown lemming)

Fishes

Thymallus arcticus (grayling)

Invertebrates

Insects

?Lygaeidae	(bug)
Elaphrus lapponicus	(ground beetle)
Bembidion (Peryphus) sp.	(ground beetle)
Pterostichus (Cryobius) spp.	(ground beetle)
Pterostichus (Cryobius) soperi	(ground beetle)
Pterostichus (Cryobius) cf. *kotzebuei*	(ground beetle)
Pterostichus (Cryobius) tareumiut	(ground beetle)
Pterostichus (Cryobius) parasimilis	(ground beetle)
Pterostichus (Cryobius) ventricosus	(ground beetle)
Pterostichus (Cryobius) brevicornis	(ground beetle)
Pterostichus (Cryobius) nivalis	(ground beetle)
Pterostichus costatus	(ground beetle)
Pterostichus haematopus	(ground beetle)
Amara alpina	(ground beetle)
Amara ?bokori	(ground beetle)
Colymbetes sp.	
Silpha coloradensis	(beetle)
Aphodius spp.	
Curimopsis sp.	(pill beetle)
Morychus sp.	(pill beetle)
Sitona sp.	

Table 8. cont'd...

Invertebrates

Insects

Leptopiinae, cf. *Ophryastes*	(weevil)
Lepidophorus lineaticollis	(weevil)
Lepyrus sp.	(weevil)
Cleonus plumbeus	(weevil)
Trichoptera	
Diptera	(biting flies)
Ichneumonoidea	(parasitic wasps)

Molluscs

Pisidium idahoense

(and other genera and species)

Ostracodes

Cytherissa lacustris

Candona acutula

Candona willmani

Candona rawsoni

Candona candida

Candona ikpikpukensis

Candona aphthalmica

Candona protzi

Cypria ophthalmica

Limnocythere liporeticulata

Limnocythere camera

Cyprinotus glaucus

Eucypris foveata

Prionocypris glacialis

Ilyocypris bradyi

Table 8. cont'd...

Plants	
Gymnosperms	
Picea mariana	(black spruce)
Angiosperms	
Potamogeton perfoliatus subsp. Richardsonii	(pond weed)
Potamogeton ?filiformis	(pond weed)
Potamogeton ?gramineus	(pond weed)
Eleocharis sp.	(sedge)
Carex sp.	(sedge)
Ranunculus trichophyllus	(buttercup)
Ranunculus cf. *pedatifidus*	(buttercup)
Potentilla sp.	

* Data on *Pisidium idahoense* - *Cytherissa lacustris* zone fossils are from J.V. Matthews, Jr. (insects and plants) and L.D. Delorme (ostracodes).

was lower and climate colder than at present. Probably the open areas in this parkland type of environment were richer in grasses than in contemporary forest-tundra areas, and the abundant remains of grazers in a fauna from Old Crow Locality 14N (Harington 1971a, p. 79) which seem to be of this period imply that this type of range was present and well-suited to these herbivores.

Unit 5 consists of laminated silty clay, which is poorly exposed and affected by slumping and flowing comparable to that of the upper glaciolacustrine unit (Unit 4) in the Old Crow Basin. Presumably a readvance of Laurentide ice blocking McDougall Pass at the peak of the Wisconsin (late Wisconsin) glaciation resulted in a re-establishment of the glacial lake and deposition of this unit. Shorelines at elevations between 1,000 and 1,800 feet (305 and 549 m) along the margin of the Bluefish Basin (Porcupine valley between Berry Creek and The Ramparts; Hughes 1972, p. 6) and Old Crow Basin probably relate to this second glaciolacustrine stage and record the gradual downcutting of the outlet at The Ramparts (Hughes 1969, p. 211). Samples from this unit are virtually devoid of ostracodes, indicating the presence of a deep, cold, turbid lake into which glacial melwater was being discharged. No pollen record is available for the upper glaciolacustrine unit.

Unit 6 is composed of transitional deposits between glacial lake and fluvial sediments. It is tentatively separated as a unit here, because the gray-brown silt with thin, peaty layers and lenses of wood suggest the predominance of fluvial rather than lacustrine deposition. No pollen record is available for the unit. I correlate it with Unit 5 at Old Crow Locality 44. Both units are of late Wisconsin age.

Unit 7 consists of peat and wood overlain by probably wind-deposited silt. It is of postglacial age as indicated by a radiocarbon date of 10,740 ± 180 years B.P. (GSC-121) from the base of the peat.

Deposition of the unit apparently commenced following drainage of the glacial lake, when the western outlet at The Ramparts eroded below the level of McDougall Pass. Laurentide ice retreated from McDougall Pass about the same time, and meltwater stopped flowing into the Bluefish Basin.

<u>Old Crow River (Locality 44)</u> -

This locality is situated 4 miles (6.4 km) northwest of the mouth of Timber Creek. It is a steep bluff on the left limit of the Old Crow River and is considered of key

importance in the area because of a relatively rich fossil zone near its base. Hughes (Lichti-Federovich 1973, p. 556 "Locality 2") and I have measured and described this approximately 100-foot (30.5 m) thick section. We are in basic agreement, except that I prefer to demarcate approximately the lower half of Hughes' Unit 2 as a separate unit, which, I think, is traceable in various parts of the Old Crow Basin, but which is covered or partly eroded in some sections.

Unit 1, the basal clay unit, is seen at most exposures on the banks of the river in the central part of Old Crow Basin. It appears to be mainly lacustrine (?glaciolacustrine) in origin. The clay varies from dark gray when moist to brown when dry. Typically it is oxidized along the joint surfaces. It includes occasional mats of organic material and exhibits a rolling surface varying about 18 feet (5.5 m) in elevation at some sites, suggesting a period when the lake became shallower and some erosion occurred in late ?Illinoian time prior to deposition of Unit 2. Unit 1 is more than 3.5 m thick at this locality. Hughes (personal communication 1975) has demonstrated to me in the field that the basal clay unit actually consists of two parts, a lower, apparently thick, biologically arid ?glaciolacustrine portion, and a shallower upper portion occasionally containing bone, plant and mollusc remains. I tentatively regard the lower part as a

subunit representing Illinoian glacial lake deposits, and the upper subunit as of latest Illinoian age.

No vertebrate remains have been found in the basal clay unit at this locality, but mammoth, horse and caribou teeth have been collected *in situ* from the upper subunit at Old Crow Localities 11 and 12. H.B. Herrington has identified the following molluscs that I collected 3 feet (0.9 m) below the contact between Units 1 and 2 at this site: *Valvata sincera*, *Valvata tricarinata*, *Amnicola limosa*, *Gyraulus* sp., *Pisidium casertanum*, *Pisidium idahoense* or *Sphaerium* sp. The abundance of *Amnicola limosa* in this sample suggests that patches of shallow or quiet water with nearby vegetation once existed there. *Candona ikpikpukensis*, an ostracode, has been identified by Delorme. From a highly compressed organic lens also located in the upper subunit of the basal clay (1 m above stream level), Lichti-Federovich has identified the following species from plant megafossils: *Menyanthes trifoliata*, *Andromeda polifolia*, Cyperaceae, *Salix* sp. (bud scales), *Picea glauca* (wing), *Abies?*, *Larix?* Therefore the upper organic subunit of the basal clay could be transitional in nature between glacial lake deposits and interglacial deposits. Perhaps Unit 5 in this section or Unit 6 at Porcupine Locality 100 are more recent analogs of this kind of transition. Evidently these deposits were laid

down between the peak of a glacial (Wisconsin) and the beginning of the following interglacial (present).

Pollen data from this unit indicate that shrub tundra vegetation, dominated by dwarf birch, but with a rich local herb element, prevailed in the region (Lichti-Federovich 1973, Figure 3, p. 562). This evidence for cold tundra climate, in conjunction with the similar composition and weathering characteristics of the deposits, leads me to suspect that Unit 1 is of Illinoian age, and that it correlates with the lower glaciolacustrine deposits (Unit 2) at Porcupine Locality 100.

Unit 2 consists of a lower fossil-bearing subunit of gray sand with silt and minor gravel, and an upper subunit of brownish clayey silt. The fossil zone contains spruce logs up to 11 inches (28 cm) in diameter, thick layers of sticks, and remains of smaller plants, mollusc shells, ostracodes, bryozoans, insects, fishes, birds and mammals (Table 9). Many of the species represented have aquatic affinities and suggest the former presence of ephemeral shallow ponds and lakes in a river flood-plain with sandy margins in places, and with forested areas, or at least open forest nearby (Harington 1974, p. 42). Ostracode fossils and the great abundance of small pond snail

Table 9. List of animal and plant fossils of ?Sangamon (>54,000 years B.P.) age from Old Crow Locality 44*.

Animals

Vertebrates

Mammals

Ochotona princeps (pika)

Lepus arcticus (arctic hare)

Spermophilus parryi (arctic ground squirrel)

Castor canadensis (beaver)

Castoroides ohioensis (giant beaver)

Dicrostonyx torquatus (collared lemming)

Lemmus sibiricus (brown lemming)

Clethrionomys cf. *rutilus* (red-backed vole)

Ondatra zibethicus (muskrat)

Microtus xanthognathus (chestnut-cheeked vole)

?Canis sp. (large canid)

Alopex lagopus (arctic fox)

Gulo gulo (wolverine)

Spilogale sp. (spotted skunk)

Mammuthus sp. (mammoth)

Equus sp. (horse)

Camelinae (camel, genus and species undetermined)

Rangifer tarandus (caribou)

Birds

Anatinae or Aythyinae (surface feeding or diving ducks)

Anserinae (geese)

Tetraonidae (ptarmigan or grouse)

Fishes

(genera and species undetermined)

Table 9. cont'd...

Invertebrates

Insects

Odonata (genus and species undetermined) (dragon flies)

Bembidion sp. (ground beetle)

Dyschirius subarticus (ground beetle)

Pterostichus (Cryobius) spp. (ground beetle)

Pterostichus (Cryobius) brevicornis (ground beetle)

Dytiscidae (genus and species undetermined) (predaceous diving beetles)

Olophrum sp. (rove beetle)

Micralymma brevilingue (rove beetle)

Tachinus sp. (rove beetle)

Colon sp. (small carrion beetle)

Aphodius spp. (dung beetle)

Symplocaria ?arctica (pill beetle)

Morychus sp. (pill beetle)

Donacia sp. (leaf beetle)

Lepidophorus lineaticollis (weevil)

Vitavitus thulius (weevil)

Trichoptera (genus and species undetermined) (caddisflies)

Ichneumonoidea (genus and species undetermined) (parasitic wasps)

Formica or *Camponotus* (ants)

Crustaceans

Lepidurus sp. (tadpole shrimp)

Daphnia sp. (water flea)

Bryozoans

Cristatella (bryozoan)

Molluscs

Helisoma sp.

Promenetus exacuous

Table 9. cont'd...

Invertebrates

Molluscs

Valvata tricarinata
Valvata sincera
Valvata cf. *mergella*
Gyraulus sp.
Amnicola limosa
Amnicola sp.
Lymnea sp.
Pleurocera sp.?
Sphaerium simile
Sphaerium striatinum
Pisidium idahoense
Pisidium lilljeborge
Pisidium casertanum
Oxyloma sp.

Ostracodes

Cytherissa lacustris
Candona ikpikpukensis

Plants

Gymnosperms

Picea ?glauca (white spruce)
Picea mariana (black spruce)

Angiosperms

Sparganium simplex (bur reed)
Najas flexilis (pond weed)
Potamogeton perfoliatus subsp. *Richardsonii* (pond weed)
Potamogeton ?filiformis (pond weed)
Potamogeton praelongus (pond weed)
Eleocharis sp. (sedge)
Carex sp. (sedge)

Table 9. cont'd...

Plants

Angiosperms

Salix sp. (willow)
Betula sp. (birch)
Alnus incana (alder)
Rumex sp. (dock)
Nuphar sp. (water lily)
Ranunculus trichophyllus (buttercup)
Ranunculus ?gmelini (buttercup)
Ranunculus ?abortivus (buttercup)
Ranunculus cf. *pedatifidus* (buttercup)
Rubus idaeus (rose)
Potentilla palustris (cinquefoil)
Potentilla sp. (cinquefoil)
Myriophyllum spicatum (water milfoil)
Hippuris vulgaris (water milfoil)
Empetrum nigrum (crowberry)
Menyanthes trifoliata (gentian)

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* I am grateful to the following people for identifications based on samples collected between 1967 and 1973 from the fossiliferous zone at the base of Unit 2: J.V. Matthews, Jr. (insects, crustaceans, bryozoans and plants); M.F.I. Smith, A.H. Clarke, G.L. Mackie and the late H.B. Herrington (molluscs); L.D. Delorme (ostracodes). Plants identified from pollen samples in Unit 2 (Pollen assemblage type II, pollen zone 2-B) collected by O.L. Hughes are listed elsewhere (Lichti-Federovich 1973, Figure 4, Old Crow 2).

(Amnicola limosa) shells indicate shallow or quiet water with nearby vegetation, as do the shells in the upper part of Unit 1 at this site. Fish, goose, duck, muskrat, beaver and giant beaver fossils support this view of the past environment.

The fossil zone seems to be concentrated in protected pockets on the rolling surface of Unit 1. Whereas the erosion on the surface of Unit 1 may have occurred during the late Illinoian, perhaps the large logs and other fossils were deposited near the peak of the Sangamon interglacial, and the finely banded clayey silts were laid down near its end.

Analyses of pollen samples from the unit show high values for spruce, birch, sedges and grasses. Compared to pollen in Unit 1, the increase in spruce at the expense of dwarf birch is remarkable, and suggests warmer, moister climatic conditions with a deeper active layer in the ground. I assume on the basis of pollen data that this unit includes sediment from the upper surface of the basal clay to a height of about 30 feet (9.1 m) in the rather homogeneous clayey silt. At this point there is a clear zonal boundary at which spruce, birch and alder decrease significantly, giving way to the grasses and sedges of a cooler climate (Lichti-Federovich 1973, p. 558).

Many radiocarbon analyses have been carried out on specimens of bone and wood from the lower, fossil-bearing subunit. Mammoth and horse bones yielded dates of >39,900 years B.P. (I-4228 and I-4223). Two samples of spruce *(Picea* sp.) and one of unidentified wood gave dates of >44,000 years B.P. (GSC-1593), >54,000 years B.P. (GSC-2066) and >39,000 years B.P. (I-3572) respectively. These dates show that the radiocarbon technique cannot measure the full age of the specimens in the fossil zone: they are more than 54,000 years old.

In summary, I (Harington 1974, p. 42) suspect that Unit 2 was deposited during the Sangamon interglacial, which ended about 70,000 years ago, for the following reasons: (a) analyses of plant and invertebrate macrofossils indicate that climate was probably as warm as the present (Matthews 1975, p. 249). Some specimens even suggest a warmer climate. One of the plants, *Najas flexilis*, has a contemporary northern limit far to the south of the Yukon Territory as does the spotted skunk *(Spilogale)*. It is worth mentioning that A.H. Clarke has identified a specimen of the freshwater mollusc *Fluminicola* sp. from a unit I correlate with Old Crow Locality 44 Unit 2 at Old Crow Locality 64, a few bends downstream from the former site. This genus is "mild temperate" in habitat. Clarke (personal

communication 1970) says that its present range is far to the south of Old Crow Basin; (b) pollen data show that Unit 2 was deposited under warmer climatic conditions than the overlying and underlying units; (c) an important erosional surface exists between the gravels of the fossil zone of Unit 2 and the underlying basal clay of Unit 1; (d) large spruce logs with roots are common in the fossil zone; (e) radiocarbon dates on wood *(Picea* or *Larix,* and *Salix)* of >42,000 years B.P. (GSC-1589, GSC-1297) from positions 25 to 70 feet (7.6 to 21 m) above the contact of Units 1 and 2 (Lichti-Federovich 1973, Figures 4, 5), suggest a much older date for the fossil zone, which is more than 54,000 years old; and (f) the great depth of burial of the fossil zone, and the fact that it lies between two geographically widespread and apparently thick deposits which were probably laid down during glacial phases.

I tentatively correlate Unit 2 at this locality with Unit 3 at Porcupine Locality 100.

Unit 3, at Locality 44, like the upper part of Unit 2, was deposited in deltaic and lacustrine situations according to Hughes (Lichti-Federovich 1973, p. 557). It consists of brown and gray banded clayey silt, and is characterized by

very high values (40 to 60%) of grass pollen, lower values for birch and spruce, and an increase in sedge pollen and in several herb types. This assemblage indicates a treeless landscape with extensive tundra dominated by sedges and grasses. It is unlikely that spruce and alder occurred in the vegetation of the basin at this time - perhaps their pollen was transported from adjacent areas of forest-tundra or forest (Lichti-Federovich 1973, p. 562). This cool, rich grassland is the type of range on which many Pleistocene mammals, such as mammoths, large-horned bison, and horses would flourish. Presumably it was toward the close of this period, represented by the upper layers of Unit 3, that man was actively hunting these animals near the lake margins in the Old Crow Basin.

The late H.B. Herrington identified mollusc shells of *Valvata sincera* and *Pisidium casertanum* from the central part of Unit 3. L.D. Delorme reported the following ostracodes from the same sample: *Candona acutula, Candona bretzi, Candona rawsoni, Cypria ophthalmica* and *Limnocythere liporeticulata.*

At Old Crow Locality 32, organic detritus a few feet from the top of Unit 3 has yielded a radiocarbon date of 31,300 ± 640 years B.P. (GSC-1191). Therefore, I suggest that Unit 3 at Locality 44 consists of sediments deposited

during early and middle Wisconsin time, and consider it to be correlative with Unit 4 at Porcupine Locality 100.

Unit 4 is composed of laminated dark gray clays deposited in a cool, deep, glacial lake. Where exposed to the sun, much of the frozen clay has melted and moved downslope in the form of solifluction lobes, so there is difficulty in measuring its thickness. This upper glaciolacustrine unit is of late Wisconsin age and is correlative with Unit 5 at Porcupine Locality 100.

Unit 5 consists of fine, yellow-brown silt which may have been deposited under deltaic conditions at the close of the Wisconsin glaciation as the glacial lake was draining. It correlates with Unit 6 at Porcupine River Locality 100.

Unit 6 is composed of silt and peaty material. Pollen data from the equivalent of this unit at Locality 32 show that about 6,500 years ago there was a change from a forest-tundra type environment to a bog or swamp environment (Lichti-Federovich 1973 Figure 4, p. 562). Poplar or aspen *(Populus* sp.) wood from near the base of the unit provided a radiocarbon date of 8,270 ± 140 years B.P. (GSC-1329), suggesting that the glacial lake had drained earlier. The unit is of postglacial age and correlates with Unit 7 at Porcupine

River Locality 100.

Before attempting to relate the Pleistocene sedimentary sequence in the Old Crow Area with that in the Fairbanks area, a few general points will be mentioned about other sections in the Old Crow Basin. High bluff sections at various points along the Old Crow River (e.g. Localities 11, 12, 15, 32, 45, 64, 88) are basically similar to Locality 44, and many produce deeply-stained vertebrate fossils from ?Sangamon sediments lying in pockets on the surface of the basal clay. In a few cases (e.g. Localities 12, 15), bones have been excavated at levels in the brownish silts that would probably lie close to the pollen boundary separating the spruce-birch environments of ?Sangamon interglacial age from the tundra grassland environment of early Wisconsin age.

Locality 11(1), which is exposed along a deep gully cutting the upper part of the high bluff at Locality 11, is unique in the Old Crow Basin because it is the only one where many late Wisconsin vertebrate fossils have been found in place. Here, large quantities of large-horned bison (*Bison crassicornis)* bones have been recovered that are about 12,000 years old. The bones have been moved only a short distance by fluvial processes, and seem to have collected as a result of some natural catastrophe. There are no

traces of human butchering on the bones, nor have artifacts been found in the deposits from which the bison specimens are derived. Presumably they died near the western slope of Schaeffer Mountain just before Glacial Lake Old Crow drained.

A younger phase of basin history is exemplified by numerous shells of large, freshwater clams *(Anodonta beringiana)* that are found at more than 13 localities (some in their original position) at, or slightly above, the level of the Old Crow River. Although these shells have a very fresh appearance, there is no record of their Recent occurrence in this part of the Yukon Territory. Two samples have yielded dates of 10,850 ± 160 years B.P. (I-4224) and 10,700 ± 160 years B.P. (GSC-1167), suggesting that the glacial lake was drained about 11,000 years ago - a date which coincides with the time of drainage of the glacial lake in the Bluefish Basin as indicated by a date on the base of peat at Porcupine Locality 100 of 10,740 ± 180 years B.P. (GSC-121). I tentatively refer to this initial stage of deep incision of the Old Crow River as the "*Anodonta* phase." In plotting various localities where these shells have been collected *in situ*, I find that they give some idea of the former (?straighter) course of the river. They are occasionally exposed in buried fluvial deposits cut into the

surface of the basal clay on opposite sides of meanders of the present river.

Following the *Anodonta* phase, the Old Crow River ceased downcutting and began aggrading, which accounts for the many constructional terraces in the central part of the basin. A radiocarbon date on peaty material in a fossil-bearing layer of brown sand and grit overlying the basal clay at Locality 22 has yielded a date of 2,420 ± 80 years B.P. (I-2755), suggesting that aggradation had begun by that time. A log 13 feet (4.0 m) higher in the section near the base of a 16-foot (4.9 m) thick stratified brown silt and silty clay unit overlying the brown sand unit yielded a date of 1,740 ± 100 years B.P. (I-2756), which implies that aggradation was slowing down about that time and may have ceased about 1000 years ago or less. A number of other localities (e.g. 5, 19, 14N, 20, 29) are similar to Locality 22. At locality 14N, the fossiliferous zone overlying the basal clay units evidently represents a point bar deposit laid down during the *Anodonta* phase. The overlying deposits are probably similar in age to those at Locality 22.

The origins of Locality 11A, one of the thickest, most productive Pleistocene vertebrate fossil sites so far

discovered in the Old Crow Basin, are difficult to explain. It yielded specimens that appear to be of Nebraskan age (e.g. *?Planisorex* cf. *dixonensis* and *Mammuthus meridionalis*), and of Kansan to Illinoian age (e.g. *Soergelia* cf. *elisabethae* and *Praeovibos priscus*). Specimens of *Bison crassicornis* of late Wisconsin age and a few species of Recent vertebrates (e.g. *Lepus* and Aves) on the surface of this point bar indicate that reworked fossils from Locality 11(1) upstream and elements of the modern fauna are occasionally deposited there. The mixed nature of this site is remarkable.

The Old Crow River probably began its second period of postglacial incision within the last 1000 years, once more cutting into the surface of the basal clay. If this renewed period of incision cannot be related to a shift in climate, such as an increase in precipitation or decrease in evapotranspiration or both, it may relate to a readjustment of basement rocks in the region resulting in establishment of a lower base level and increased erosion.

The peculiar rectangular shapes of larger lakes in the Old Crow Basin have been attributed by various people to control by rectangular joint systems in the basement rocks, a tilting of the basin floor, or direction of pre-

vailing winds (O.L. Hughes and J. Westgate, personal communications 1976). An attempt to explain this phenomenon would constitute an interesting research project.

Suggested Stratigraphic Relationships between the Old Crow and Fairbanks Areas -

The following views are offered in the belief that it is useful to have a hypothetical regional stratigraphic framework available for future revision or refinement.

Péwé (1975b, p. 9) described a section from Eva Creek near Fairbanks, Alaska which evidently covers a period in the Pleistocene extending from pre-Yarmouth? to Recent. I wish to emphasize a broad similarity in the section at Porcupine Locality 100 and the Eva Creek section near Fairbanks. Both consist of two thick sedimentary deposits bounded at the top and bottom, and separated in the middle by thinner units having relatively high concentrations of vegetation (some are called "forest beds"). I speculate that the two thicker deposits show relatively high rates of deposition to be expected during glacial periods in such unglaciated regions, and that the three thinner deposits display lower rates of deposition (more active erosion) and consolidation by well-developed

plant cover including boreal forest, to be expected during interglacial periods in these areas.

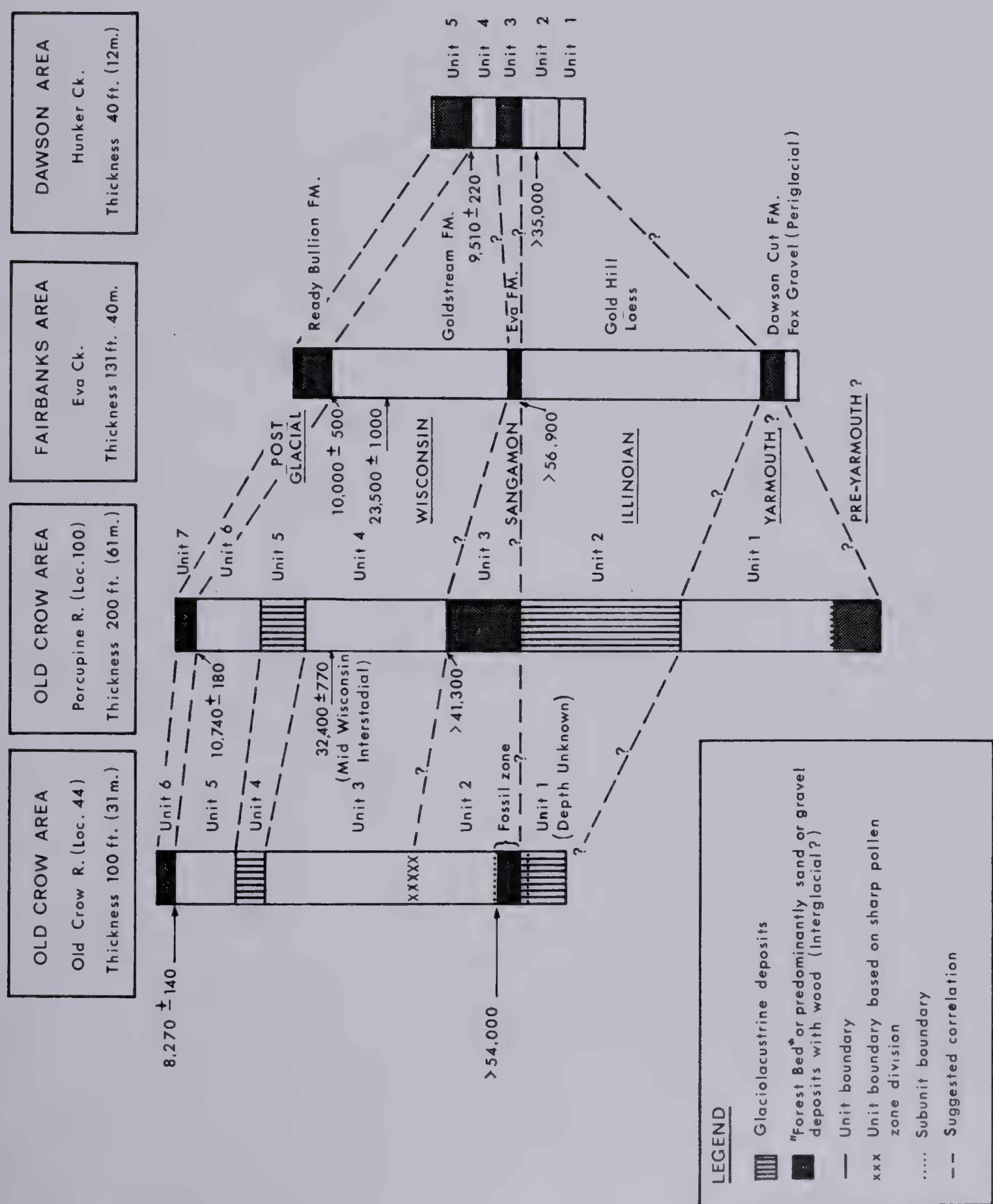
There is no doubt that the uppermost unit (Ready Bullion Formation) at Eva Creek, a thin widespread deposit of frozen silt, rich in organic material, is of postglacial age and correlative with the uppermost peat units at Porcupine Locality 100 and Old Crow Locality 44, because radiocarbon dates from it span the period from 3,750 ± 200 years B.P. (L-117H) to 10,000 ± 500 years B.P. (L-137S).

At Porcupine Locality 100 and Old Crow Locality 44, glacial maxima seem to have been well marked by the formation of two, successive glacial lakes evidently caused by Laurentide ice dams at McDougall Pass. The cold, deep lake stages are expressed stratigraphically in the upper and lower glaciolacustrine units. In the Fairbanks area of central Alaska, where drainage was better, the glacial periods are evidently marked in the lowest parts of the valleys (e.g. Eva Creek) by another process - a great influx of wind blown loess from the margins of large ice masses to the north (Brooks Range) and south (Alaska Range) or accumulation of reworked loess through mass wastage. Thus, the glacials are stratigraphically expressed in the Eva Creek section by thick loess units (Goldstream

Formation and Gold Hill Loess).

Tentatively assuming that these separate processes were operating during the same periods in the Old Crow and Fairbanks areas, I suggest: (a) that the Goldstream Formation (Wisconsin), which has yielded radiocarbon dates from 23,300 ± 1000 years B.P. (W-435) to over 30,000 years B.P. (L-163J), is correlative with the upper glaciolacustrine unit (5) and its associated units (4 and 6) at Porcupine Locality 100, and the upper glaciolacustrine unit (4) and its associated units (3 and 5) at Old Crow Locality 44; (b) that the Eva Formation (Sangamon) "forest bed" correlates with the gravel layer with wood (Unit 3) at Porcupine Locality 100 and the layer with fossils and big logs (Unit 2) at Old Crow Locality 44. A stump from the forest bed at Eva Creek yielded a radiocarbon date of >56,900 years B.P. (Hv-1328), which corresponds to those of >54,000 years B.P. (GSC-2066) from a large piece of wood from Unit 2 at Old Crow Locality 44 and a date of >41,300 years B.P. (GSC-199) from wood in the upper part of Unit 3 at Porcupine Locality 100; (c) that the Gold Hill Loess (Illinoian) correlates with the lower glaciolacustrine sediments (Unit 2) at Porcupine Locality 100 and with the basal clay (Unit 1) at Old Crow Locality 44; and (d) that the Dawson Cut Formation (Yarmouth?) forest bed is correlative with Unit 1 at Locality 100 (Figure 5).

Figure 5. Suggested stratigraphic relationships among some Pleistocene deposits bearing vertebrate fossils in Eastern Beringia (Old Crow, Fairbanks, and Dawson areas).


OLD CROW AREA
Old Crow R. (Loc. 44)
Thickness 100 ft. (31 m.)
OLD CROW AREA
Porcupine R. (Loc. 100)
Thickness 200 ft. (61 m.)
FAIRBANKS AREA
Eva Ck.
Thickness 131 ft. 40m.
DAWSON AREA
Hunker Ck.
Thickness 40 ft. (12m.)
8,270 ± 140
>54,000
Unit 6
Unit 5
Unit 4
Unit 3
(Mid Wisconsin Interstadial)
32,400 ± 770
Unit 2
Fossil zone
Unit 1
(Depth Unknown)
xxxxx
10,740 ± 180
>41,300
Unit 7
Unit 6
Unit 5
Unit 4
Unit 3
Unit 2
Unit 1
POST GLACIAL
10,000 ± 500
23,500 ± 1000
WISCONSIN
SANGAMON
>56,900
ILLINOIAN
YARMOUTH ?
PRE-YARMOUTH ?
Ready Bullion FM.
Goldstream FM.
Eva FM.
Gold Hill Loess
Dawson Cut FM.
Fox Gravel (Periglacial)
9,510 ± 220
>35,000
Unit 5
Unit 4
Unit 3
Unit 2
Unit 1
LEGEND
Glaciolacustrine deposits
"Forest Bed" or predominantly sand or gravel deposits with wood (Interglacial?)
Unit boundary
xxx Unit boundary based on sharp pollen zone division
..... Subunit boundary
-- Suggested correlation

Péwé's (1975b, p. 9) description of the Dawson Cut Formation closely corresponds with my field notes on Unit 1 at Porcupine Locality 100: - "a well-developed organic silt crops out. This unit contains large stumps and logs that are partly flattened and deformed; it is thought to represent an interstadial or interglacial forest bed. One particularly fine white spruce stump from the Dawson Cut Formation of the Eva Creek sections with roots in the underlying gravel is more than 28,000 years old (L-137X)." He also noted peaty layers in the formation, gray to tan silt, and gravel and some basal silt cemented by an iron oxide compound (cf. Hughes 1972, Table 1, Unit 1).

It might be valuable if fossil spruce cones could be found in the Dawson Cut Formation and compared to those from Unit 1 at Porcupine Locality 100, the sizes of which indicate a stage of evolution between late Tertiary *Picea banksii* and *Picea glauca*, the living white spruce.

Another way of checking the correlation between Old Crow and Fairbanks areas would be to compare the results of analyses of a series of geomagnetic samples from various levels in the main sections, in the hope that certain reversals could be detected and used as marker horizons (e.g. Johnson *et al.* 1975). Tephrochronology also appears

to offer a powerful tool for correlation between regions in Eastern Beringia, where Pleistocene ash falls derived largely from former volcanic activity in the St. Elias Range are widespread. The Dome Ash Bed, which is exposed within and near the surface of the Gold Hill Loess in the Fairbanks area, could be a useful Illinoian marker if microprobe analyses show some uniqueness in its composition. Another possible marker of early Illinoian time is the Ester Ash Bed which is exposed, in places, near the base of the Gold Hill Loess (Péwé 1975b, p. 12). Although tephra layers seem to be rare in the Old Crow Area, they are commonly found in the Dawson Area, so chances for using this method to correlate the Dawson and Fairbanks areas seem most promising.

Dawson Area

I have found no exposures in the Dawson Area which offer the stratigraphic detail and time range of the Eva Creek section near Fairbanks. Perhaps periodic heavy erosion has removed, or truncated early and middle Pleistocene deposits, leaving only a vestige of the Pleistocene record. On the other hand, a lack of detailed stratigraphic study near Dawson may, at least in part, be responsible for gaps in our knowledge of the Pleistocene

history of the region. The sequence of deposits at Pleistocene mammal localities in the Dawson Area is commonly as follows: (1) schistose bedrock; (2) oxidized gold-bearing gravels of ?interglacial age; (3) a muck layer of probable Wisconsin age; (4) a surface layer of postglacial peat. Sections like this do not appear to offer much scope for the stratigrapher. A possible exception is found on Hunker Creek.

Hunker Creek (Dawson Locality 12) -

This locality, now abandoned and largely overgrown by vegetation, is situated on the left limit of Hunker Creek between Too Much Gold and Gold Bottom creeks. Stratigraphic relationships at the site have been summarized and illustrated by Hunter and Langston (1964, Figure 1) on the basis of O.L. Hughes' field notes.

Unit 1 consists of gold-bearing gravel which overlies bedrock.

Unit 2 is an organic silt or muck deposit. Where this unit has been eroded away, mammal bones are concentrated on the surface of the gold-bearing gravel (Unit 1), and are overlain by silt and peat equivalent to Units 4, 5 and 6 of Hughes. Radiocarbon analysis of spruce *(Picea* sp.) wood from

the unit has yielded a radiocarbon date of >35,000 years B.P. (I(GSC)-181).

Unit 3 consists of silty gravel. Hughes considered that mammal bones from the locality were derived from this unit. However, bone from a complete skull of "*Equus lambei*" that was collected from this layer yielded a Recent radiocarbon date. In my opinion the skull represents a modern horse (*Equus caballus*); for example, the anteroventral margin of the mandible lies flat on a horizontal surface like *Equus caballus*, and unlike *Equus (Asinus) lambei*, which rises at this point (Harington and Clulow 1973, p. 717). Small strings of decayed flesh adhering to the bone reinforce this view of the skull's recency. The horse may have been buried in a pit by early miners, and exposed in the course of monitoring back the frozen muck. Other bones that were evidently found in this unit may have been concentrated from Unit 2 during a minor erosional cycle.

Unit 4 is composed of organic silt or muck.

Unit 5 consists of silty peat with abundant wood near the bottom. It lacks wood in the upper surface. Although Hughes treated this as two separate units (5 and 6), I prefer to recognize it as a single unit deposited

during the postglacial time. Peat from near the base of the woody portion yielded a radiocarbon date of 9,510 ± 220 years B.P. (GSC-196).

At this site, the possibility exists that the silty gravel of Unit 3 indicates a period of erosion that cut away muck of ?Illinoian age (Unit 2) during Sangamon interglacial time. If so, then Unit 4 would correlate with the Goldstream Formation at Fairbanks, which Péwé (1975b, p. 15) says - "is the greatest repository of remains of Pleistocene vertebrates in Alaska, if not in North America", and Unit 2 would be equivalent to the Gold Hill Loess (Figure 5). Apparently most of the pre-Wisconsin valley bottom deposits near Dawson have been removed, otherwise more radiocarbon dates on Pleistocene bone would be infinite. Only one specimen out of 12 from the Dawson Area has produced an infinite radiocarbon date (Table 5).

Analyses of volcanic ash layers may help to solve this stratigraphic problem. O.L. Hughes has collected tephra samples from the area, and I have collected others from the muck at the mouth of 80 Pup on lower Hunker Creek (Dawson Locality 10), on the right limit of Gold Bottom Creek (Dawson Locality 15), and at Glacier Creek (Sixtymile Locality 4). These samples have been

sent to J. Westgate for electron microprobe analyses, in an attempt to ascertain their composition, age and correlative value.

RESULTS

I. Faunal List

Class Mammalia

Order Insectivora

Family Soricidae

?Planisorex cf. *dixonensis* (plains shrew)

Order Primates

Family Hominidae

Homo sp. (man)

Order Endentata

Family Megalonychidae

Megalonyx cf. *jeffersoni* (ground sloth)

Order Lagomorpha

Family Ochotonidae

Ochotona cf. *whartoni* (giant pika)

Ochotona princeps (pika)

Family Leporidae

Lepus americanus (snowshoe hare)

Lepus arcticus (arctic hare)

Order Rodentia

Family Sciuridae

Marmota cf. *monax* (woodchuck)

Spermophilus parryi (arctic ground squirrel)

Family Castoridae

Castor canadensis (beaver)

Castoroides ohioensis (giant beaver)

Family Cricetidae

Dicrostonyx cf. *henseli* (Hensel's lemming)

Dicrostonyx torquatus (collared lemming)

Lemmus sibiricus (brown lemming)

Family Cricetidae

Clethrionomys cf. *rutilus* (red-backed vole)
Ondatra zibethicus (muskrat)
Microtus (Stenocranius) miurus (singing vole)
Microtus xanthognathus (chestnut-cheeked vole)

Order Cetacea

Family indeterminate

Genus and species indeterminate (large whale)

Order Carnivora

Family Canidae

Canis lupus (wolf)
Canis familiaris (domestic dog)
Alopex lagopus (arctic fox)
Vulpes vulpes (red fox)
Cuon sp. (dhole)

Family Ursidae

Arctodus simus yukonensis (Yukon short-faced bear)
Ursus cf. *americanus* (American black bear)
Ursus arctos (brown bear)

Family Mustelidae

Mustela erminea (ermine)
Mustela (Putorius) eversmanni (black-footed ferret)
Martes nobilis (noble marten)
Martes pennanti (fisher)
Gulo gulo (wolverine)
Taxidea taxus (badger)
Spilogale sp. (spotted skunk)
Lontra canadensis (Nearctic river otter)

Family Felidae

Felis (Lynx) canadensis (Canada lynx)
Felis (Puma) cf. *concolor* (mountain lion)
Panthera leo atrox (American lion)
Homotherium serum (American scimitar cat)

Family Phocidae

Phoca cf. *(Pusa) hispida* (ringed seal)

Order Proboscidea

Family Mammutidae

Mammut americanum (American mastodon)

Family Elephantidae

Mammuthus meridionalis (southern mammoth)

Mammuthus cf. *armeniacus* (steppe mammoth)

Mammuthus primigenius (woolly mammoth)

Order Perissodactyla

Family Equidae

Equus cf. *(Plesippus) verae* (large horse)

Equus sp. (giant horse)

Equus cf. *scotti* (medium-sized horse)

Equus (Asinus) lambei (Yukon wild ass)

Equus (Asinus) cf. *kiang* (kiang - like wild ass)

Order Artiodactyla

Family Camelidae

Camelini (genus and species undetermined) (large camel)

Camelops hesternus (western camel)

Family Cervidae

Cervus elaphus (wapiti)

Alces latifrons (giant moose)

Alces alces (moose)

Rangifer tarandus (caribou)

Cervidae (genera and species undetermined)

Family Bovidae

Bison alaskensis (Alaskan bison)

Bison crassicornis (large-horned bison)

Bison bison occidentalis (western bison)

Bison bison athabascae (wood bison)

Family Bovidae

Soergelia cf. *elisabethae* (Soergel's muskox)

Boötherium sargenti (Sargent's Muskox)

Symbos cavifrons (helmeted muskox)

Praeovibos priscus (Staudinger's muskox)

Ovibos moschatus (tundra muskox)

Ovis ?dalli (Dall sheep)

II. Systematic Description of Yukon Pleistocene Mammals

Class Mammalia

Order Insectivora

Family Soricidae

?Planisorex cf. *dixonensis* (plains shrew)

A single specimen of a shrew (Figure 6A-B, Table 10) has been collected from Yukon Pleistocene deposits. It is not only of interest because of its rarity, but because it appears to represent a kind of shrew that lived in southern North America during the early Pleistocene.

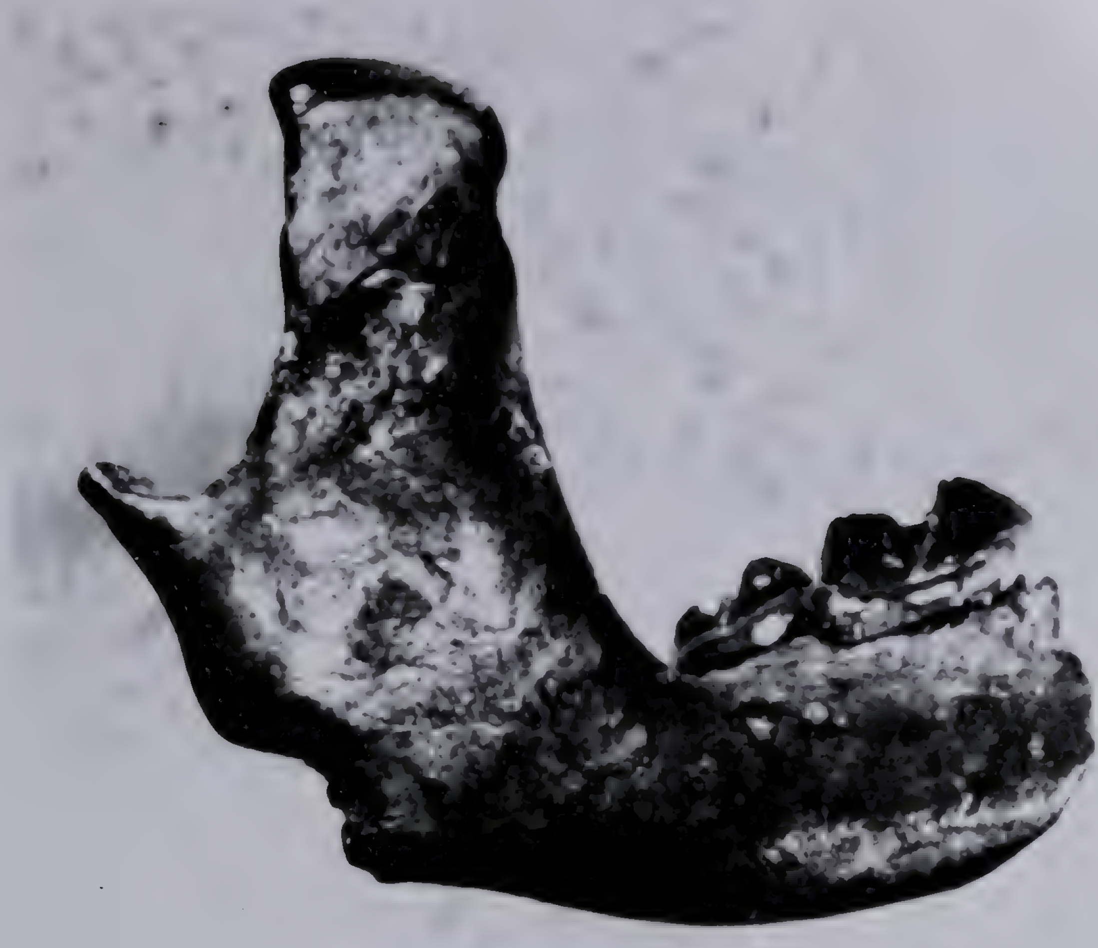
Referred specimen

OCR 9448 from Old Crow Locality 11A is a right mandibular fragment with well worn RM_2-RM_3. The angular process is damaged and the mandible anterior to RM_2 is lacking. The specimen is stained black. I consider it to be of pre-late Wisconsin age. A field crew under W.N. Irving collected the specimen in 1975, and I am grateful to him for allowing me to examine and describe it.

The fossil differs from any Recent Canadian shrew mandibles to which it was compared, being much larger than *Sorex arcticus* or *Microsorex hoyi*, and slightly smaller than the short-tailed shrew,

Figure 6. Posterior of right mandible with RM_2-RM_3 of a Plains shrew *(?Planisorex* cf. *dixonensis)* (OCR 9448) from Old Crow Locality 11A. A. Lateral view. B. Medial view.

A



B

3 MM

Table 10. Measurements of a Pleistocene plains shrew (*?Planisorex* cf. *dixonensis*) mandible from the Yukon Territory compared to those of early Pleistocene plains shrew (*Planisorex dixonensis*) mandibles from Kansas and Nebraska.

Specimens	Measurements (mm)*						
	1	2	3	4	5	6	7
?Planisorex cf. *dixonensis*.Pleistocene, Y.T.							
OCR 9448 Old Crow Loc. 11A	5.5	2.9	1.8	1.5	1.0	1.1	0.7
Planisorex dixonensis.Early Pleistocene, U.S.A. (Skinner *et al.* 1972, Table 6).							
UMMP V31986 (type) Kingman Co., Kansas	-	-	-	1.54	0.95	0.93	-
UMMP V57083 Brown Co., Nebraska	-	-	-	1.68	1.06	1.10	-

* 1 - Height of ascending ramus
2 - Anteroposterior diameter of ascending ramus at sigmoid notch
3 - Minimum depth of mandible posterior to M_3
4 - M_2 length
5 - M_2 width
6 - M_3 length
7 - M_3 width

Blarina brevicauda. It also differs from *Blarina brevicauda* in its more upright ascending ramus (that of the short-tailed shrew flares outward superiorly), in its markedly smaller diameter of the ascending ramus (at the level of the sigmoid notch), and in its lower coronoid spicule.

The original specimen was sent to C.A. Repenning for identification. The following paragraph is basically a summary of his (C.A. Repenning, personal communication 1976) comments, which are gratefully acknowledged. The Yukon fossil is definitely assigned to the Tribe Soricini. The long trigonid, the well developed entoconid crest of RM_3, and the lack of an interarticular plate (broad interarticular area) between the superior and inferior condyles indicate that OCR 9448 does not belong to the Tribe Blarinini. The extreme anterior position of the superior condyle, the nature of the internal temporal fossa, the high external temporal fossa, and the apparent lack of similarity with any known neomyine genus evidently rules out the possibility of its belonging to the Tribe Neomyini. There is, however, a considerable similarity between OCR 9448 and the mandible of the extinct plains shrew, *Planisorex dixonensis*, in the situation of the mandibular condyles,

the low, well developed coronoid spicule, the elongate talonid on RM_2 and RM_3, the low cusps, and the prominent labial cingulum on the teeth (Hibbard 1956, pp. 162-163; Skinner *et al.* 1972, pp. 78-79).

As no direct comparison has been possible between OCR 9448 and the type specimen of *Planisorex dixonensis*, a posterior part of a left mandible with LM_1-LM_3 (UMMP V31986) from the early Pleistocene (Nebraskan) Belleville Formation of Kingman County, Kansas, the exact generic designation of the Yukon specimen is doubtful. Pending detailed comparisons with the type, OCR 9448 is referred to *?Planisorex* cf. *dixonensis*.

Discussion

This is the first report of the plains shrew in Canada and Eastern Beringia. OCR 9448 is almost certainly of pre- late Wisconsin age because of its deep staining, and I suspect it is of early Pleistocene age because all other fossils referred to *Planisorex dixonensis* have been collected from early Pleistocene sediments. The only other shrew remains reported from Canada are of *Blarina brevicauda* from Lake Iroquois deposits at Hamilton, Ontario, which may date between 5,000 and 6,000 years B.P. (Wetmore 1958, pp. 9-10; Churcher and Karrow 1963, p. 153).

Shrew remains from the Pleistocene sediments of Alaska are nearly as rare. Two partial mandibles identified as *Sorex* sp. by Guthrie and Matthews (1971, p. 404) are recorded from the Cape Deceit Formation (?Nebraskan) near Deering. In 1955, W.O. Pruitt, Jr. found well preserved skeletal remains of a shrew *in situ* in an arctic ground squirrel *(Spermophilus parryi)* nest that was enclosed in permafrost approximately 25 feet (7.6 m) below the surface of the ground at Fairbanks Creek. The matrix consisted of silt and fine pebbles. A letter from Pruitt to C.W. Hibbard dated February 4, 1957, with the shrew remains (now preserved in the Museum of Paleontology, University of Michigan) mentions the discovery of a nest with an arctic ground squirrel curled up inside it in a position typical of hibernation. Pruitt thought the shrew had died going after the ground squirrel or its seed cache - evidently a fascinating record of "fossil behavior". Hibbard tentatively identified the specimen as a tundra shrew *(Sorex tundrensis)*. The shrew bones are quite fresh looking, and are probably of late Wisconsin age.

The shrews evidently began their radiation before the Oligocene (Repenning 1967, Figure 42). *Crocidosorex*, of late Oligocene and early Miocene age, probably gave rise to the three tribes of Soricinae (Blarinini, Neomyini,

Soricini). Probably the Soricinae first reached North America from Eurasia via the Bering Isthmus in the early Miocene (Repenning 1967, p. 63). *Alluvisorex* was near the stem of the two generic groups within the Soricinae: (a) *Blarinella* and its associated genus, *Petenyia;* and (b) *Sorex* and its associated genera *(Planisorex, Drepanosorex* and *Microsorex).* Repenning (personal communication 1976) notes a considerable similarity of OCR 9448 and *Planisorex dixonensis* to the European middle Pleistocene genus *Drepanosorex.*

Planisorex dixonensis, a monotypic species, is only known from early Pleistocene (late Blancan) deposits of Kingman County, Kansas and Brown County, Nebraska. Evidently OCR 9448 extends the Pleistocene range of this species some 2,400 miles (3,860 km) northward from Nebraska.

Thus, the plains shrew may have had its origins in southern North America in the early Pleistocene and ranged from southern Kansas to the northern Yukon. Probably *Planisorex dixonensis* was slightly smaller in size than the short-tailed shrew, *Blarina brevicauda*, which is one of the largest (5 inches (12.7 cm) long) living American shrews. Probably insects formed the bulk of its diet. Nothing is known of the environmental requirements of this species.

Order Primates

Family Hominidae

Homo sp. (man)

So far, only indirect evidence of early man in the Yukon is available. Nevertheless, it is quite persuasive. On July 12, 1966, during my first trip up Old Crow River, I located a productive fossil locality (14N) between the mouth of Schaeffer and Johnson creeks. At this site, Peter Lord found a fleshing tool (Figure 7A) made from the tibia of a small caribou. Examination of the artifact showed that someone had applied a few glancing blows to the upper tibial shaft. The edges of the resulting fracture had then been pared down with a sharp cutting tool of stone, and the spatulate "blade" was notched to form about 12 tines or teeth, eight of which are preserved. A number of Canadian Indian groups still make similar fleshing tools from moose metapodials. They are used to remove excess tissues from the inside of a hide. The methods of making them may vary considerably and none is identical to the Old Crow example.

Because further work indicated that the fossil-bearing sediments at the site - in this case oxidized sandy gravel - were point bar deposits laid down a few

thousand years earlier and contained relatively recent and very old wood, W.N. Irving and I decided to obtain radiocarbon dates on the fleshing tool and two other bones worked by man. The flesher yielded a date of 27,000 $^{+3,000}_{-2,000}$ years B.P. Dates on a mammoth long bone fragment and the upper end of a mammoth radius, both of which had flakes removed by heavy blows when fresh, were 25,750 $^{+1,800}_{-1,500}$ years B.P. and 29,100 $^{+3,000}_{-2,000}$ years B.P., respectively.

We (Irving and Harington 1973) concluded that man had evidently lived in the eastern part of Beringia before the peak of the last glaciation. He had sharp stone tools for working bone, and he had developed ways of breaking large mammoth bones. Probably he hunted mammoth and caribou and prepared skins for use as clothing and shelter.

<u>Referred specimens</u>

During the course of this project, several specimens that appear to be artifacts have been collected since 1966 from other localities along the Old Crow River. Part of a deeply stained horse mandible from Old Crow Locality 22 bears facets that were made by man before the bone became mineralized. Hansjurgen Müller-Beck of the University of Freiburg (personal communication 1970) noted that the incisor teeth had been removed and that the sockets had been worked by man. A fossilized caribou antler with four well-

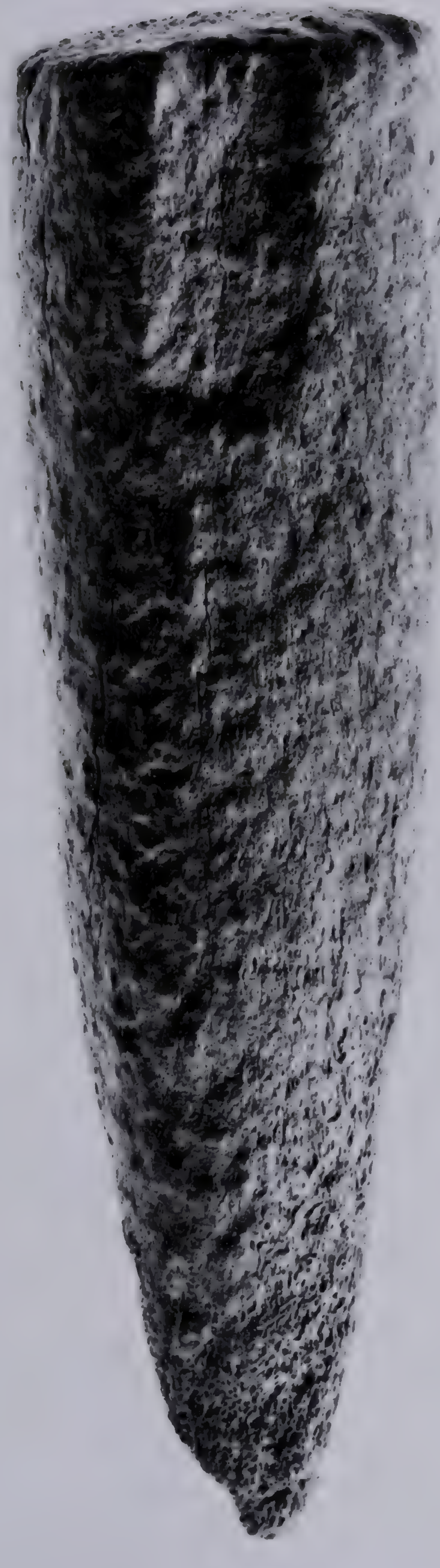
Figure 7. Human artifacts from Pleistocene deposits of the Yukon Territory.

A. Fleshing tool made from the tibia of a small caribou *(Rangifer tarandus)* from Old Crow Locality 14N.

B. Side view of a punch made from caribou antler (Dawson Locality 16).

A

B



defined facets on its base could have been used as a pestle or a skin softener (Figure 8C). It was collected at Old Crow Locality 29. Three more faceted bones were collected in 1975: a naviculocuboid (Old Crow Locality 108) with a facet on the upper surface; a lower cheek tooth of a horse (NMC 28601, Old Crow Locality 134) faceted on the labial surface; and the distal half of a horse humerus (NMC 28446, Old Crow Locality 143) with facets on either side of the olecranon fossa. As the facets on the latter specimen, although adjacent, are not on the same level or plane, working by man is indicated rather than smoothing by natural forces of friction.

In 1975 the proximal part of a caribou antler (NMC 27115, Old Crow Locality 29) was collected. The brow tine had been removed, the base was faceted and impact-scarred, and there were paring surfaces on the bez tine. Apparently this antler fragment was used in a hammer-like fashion, with the bez tine as a handle, for striking off stone blades from a core by direct impact.

A bone tool has also been found in the Dawson Area (Harington 1975b, p. 5). In 1973 I collected a large, bullet-shaped piece of caribou antler evidently shaped by early man for use as a punch (a bone tool for making chert

or obsidian tools by flaking) (Figure 7B). C. Borden (personal communication 1976) suggests the tool may have been used as a wedge. It came from the placer operation of John Erickson and Herman Liedtke on upper Hunker Creek (Dawson Locality 16). Specimens of woolly mammoth, American lion, Yukon wild ass, large-horned bison, extinct muskox *(Symbos cavifrons)* and other caribou fossils were found with the artifact. It appears to be the first tool recognized from ice age deposits in that part of the Yukon Territory. Radiocarbon analysis of a caribou antler from the same locality as the punch yielded a date of 23,900 ± 470 years B.P. (I-8580). Evidence of butchering was noted on the basal region of a bison skull collected from Sulphur Creek (Dawson Locality 17) in 1975 (Figure 8A).

Stone tools have also been found in gravel deposits along the Old Crow River (Harington 1975a, p. 121). In 1971 Charlie Thomas excavated a finely flaked, black obsidian biface at Old Crow Locality 20 near the mouth of Black Fox Creek. In 1973 a black chert biface was excavated at Old Crow Locality 11A. Its maximum measurements are 80 mm. long, 43 mm. wide and 10 mm. thick. The fact that one edge of the artifact is more heavily flaked than the other may indicate that it was used as a knife. In 1975, G.R. Fitzgerald collected a black chert bifacial "knife" from the

Figure 8. Human artifacts from Pleistocene deposits of the Yukon Territory. A. Ventral view of the basioccipital region of a ?young bison (*Bison* sp.) from Dawson Locality 17 showing butchering marks on the basioccipital and the paramastoid processes. B. Side view of a lanceolate spear point made from black chert (Old Crow Locality 138). C. Faceted base of a caribou (*Rangifer tarandus*) antler (Old Crow Locality 29). D. Side view of a bifacial "knife" made from black chert (Old Crow Locality 22).


A
B
C
D
3 CM
3 CM
3 CM

bank of the Old Crow River at Locality 22 (Figure 8D). Like the specimen from Old Crow Locality 11A, it is finely retouched along one edge. The opposite edge is flat, providing a place where pressure could be applied by the index finger. Its maximum measurements are 99.4 mm. long x 43.7 mm. wide and 13.2 mm. thick. Later in 1975, I found a complete, lanceolate, black chert spear point at Old Crow Locality 138 (Figure 8B). Its maximum measurements are 112.2 mm. long x 32.9 mm. wide and 12.2 mm. thick. Although many Pleistocene vertebrate species were found in the gravel deposits from which these stone tools were derived, the age of the stone tools is unknown. All of the artifacts mentioned are preserved in collections of the Archaeological Survey of Canada.

Discussion

In the absence of deeply buried dwelling sites, which many archeologists require as evidence of the presence of early man, R. Bonnichsen had demonstrated by other means the validity of the present scanty evidence (Harington *et al.* 1975). His experiments indicate by use of comparative collections of different types of geologically, biologically and culturally altered material, how bones altered by man can be distinguished from those broken or polished by natural agencies, such as wind, water and freeze-thaw cycles in permafrost. Bones broken by man usually show spiral fractures

instead of rectangular breaks characteristic of natural processes. But spirally-fractured bone, by itself, is not necessarily indicative of human modification. Negative impact scars and fracture surfaces that have features oriented toward the point of impact are additional clues in distinguishing bones broken by man from those altered by other agencies.

Bonnichsen found that more than 30 of 115 fossil localities in the Old Crow Area have yielded modified bones and artifacts, hundreds of which have been broken by spiral fractures. Mammoth, bison, horse and caribou bones have been modified in this way: in some cases they have been made into tools. Bonnichsen's experiments clearly demonstrate that it would not have been feasible for modern Indians to rework the fossils because of the brittleness and rectangular fracture patterns of mineralized bone; therefore, the radiocarbon date on the caribou fleshing tool and the mammoth limb bone fragments mentioned above evidently indicate the time when they were made.

There is a growing body of evidence to suggest that man entered North America over 20,000 years ago (Kennedy 1975, p. 274). Although it is possible that man may have reached other parts of America by sea at earlier periods, the data from Old Crow support the hypothesis that late Pleistocene hunters, seeking abundant game such as mammoths

and bison, crossed the Bering Isthmus during a glacial interval prior to mid-Wisconsin time. Problems remain concerning the physical characteristics and ways of life of these early people, in addition to how and when they first penetrated the southern part of North America and South America. Hopefully, further research will yield answers to these questions.

Order Endentata

Family Megalonychidae

Megalonyx cf. *jeffersoni*
(Jefferson's ground sloth)

Remains of Jefferson's ground sloth are rarely found in the Old Crow Area (Harington 1970, p. 45; 1971a, pp. 81-82). None has been found in the Dawson Area. Most specimens are fragmentary and are stained deep brown to black. Teeth and phalanges are best preserved.

<u>Referred specimens</u>

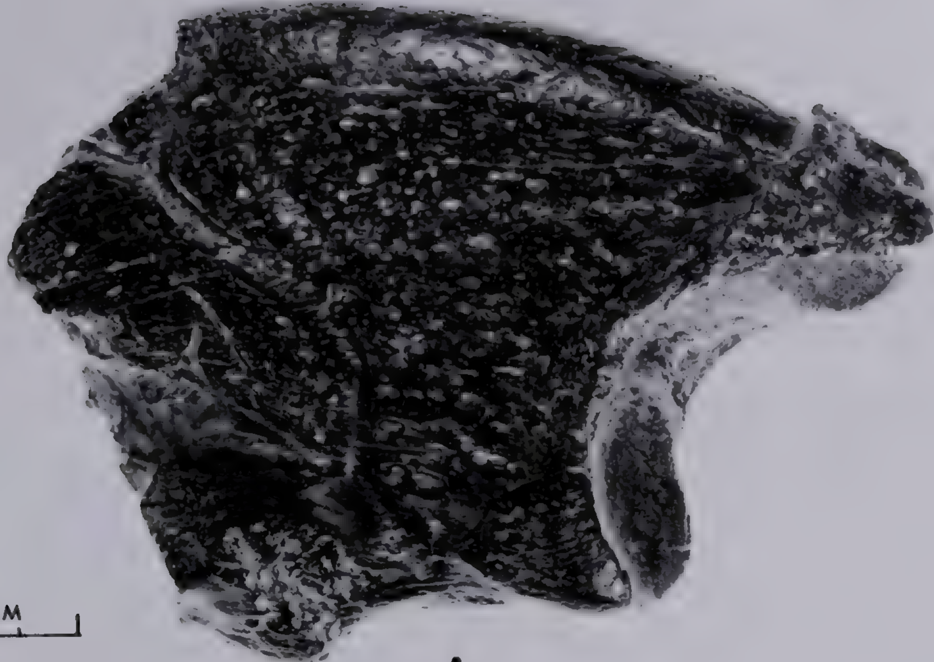
Four teeth are represented from the Old Crow Basin (Figures 9A-E, Table 11). A caniniform (NMC 24215, Old Crow Locality 66) is considered to be an LC_1, taking the narrower end as anterior and the thickest outer zone of the tooth as seen from the occlusal surface as the lateral surface (Lundelius 1972, p. 33, Figure 27). The occlusal surface is rough as if partly broken or chipped, whereas the

Figure 9. Ground sloth *(Megalonyx* cf. *jeffersoni)* remains from Yukon Pleistocene deposits.

A. Side view of an ungual phalanx of the third digit of the manus (NMC 26193, Old Crow Locality 11A). The hooked end of this claw is missing.

B. Left side view of a second phalanx of the third digit (NMC 28550, Old Crow Locality 144).

C. Posterior view of NMC 28550. D. Top view of a left astragalus (NMC 25148, Old Crow Locality 66). E. Bottom view of NMC 25148.



3 CM

A

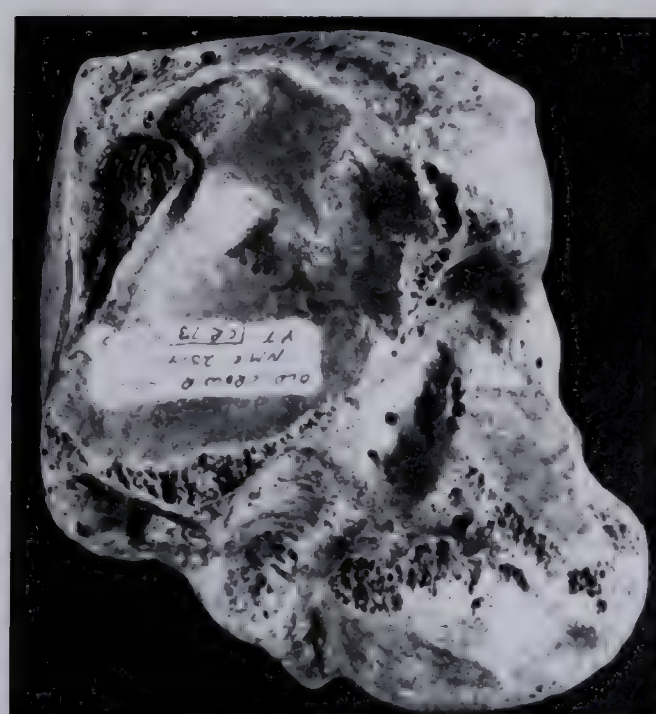
B

C

3 CM

3 CM

D



E

Table 11. Measurements of Pleistocene ground sloth *(Megalonyx* cf. *jeffersoni)* teeth from the Yukon Territory compared to those of *M. jeffersoni* from Robinson Cave, Tennessee (Guilday *et al.* 1969, p. 67).

Specimens	Tooth	Measurements (mm)*	
		1	2
NMC 24192 Old Crow Loc. 11A	M^1	15.7	20.8
CM 12528 Robinson Cave, Tenn.	M^1	16.0	19.0
CM 12527 (cast) Robinson Cave, Tenn.	M^1	14.0	18.0
NMC 19203 Old Crow Loc. 22	M^4	11.8	19.0
CM 12527 (cast) Robinson Cave, Tenn.	M^4	10.8	18.0
NMC 24215 Old Crow Loc. 66	C_1	36.0	16.0
CM 12528 Robinson Cave, Tenn.	C_1	40.0	17.0
TSM uncatalogued Robinson Cave, Tenn.	C_1	35.0	16.0
CM 12527 (cast) Robinson Cave, Tann.	C_1	34.0	17.0

* 1 - Maximum length.

2 - Maximum width.

inferior labial margin has been sharply fractured. Only the upper labial region shows the fine pattern of vertical striations characteristic of the original surface of the tooth. It compares closely in size to other lower caniniforms of *M. jeffersoni* from Robinson Cave, Tennessee. A fragmentary RM^1 (NMC 24192, Old Crow Locality 11A) lacks parts of the lingual and occlusal surfaces, and the base of the tooth. Vertical striations are apparent on the outer surface of the specimen. It compares closely with measurements of *M. jeffersoni* M^1s from Robinson Cave (Table 11). The lower part of an RM^4 (NMC 19203, Old Crow Locality 22) has a well preserved occlusal surface, except for the lingual margin. Again, it compares well with another *M. jeffersoni* M^4 from Robinson Cave. Another upper molar (NMC 14528, Old Crow Locality 22) is on display in the National Museum of Natural Sciences in Ottawa.

A left astragalus (NMC 25148, Old Crow Locality 66) is eroded on the margin of the fossa articulating with the scaphoid. It is comparable in size to adult *Megalonyx* astragali from Big Bone Cave (Wisconsin age), American Falls, Idaho (Illinoian? age) and a specimen from Alabama (Wisconsin? age) (G. McDonald, personal communication 1975).

A right calcaneum (NMC 24194, Old Crow Locality 66) lacks the distal half including the tuberosities, and also bone lateral to the articular facets for the astragalus. It is about half the size of calcanea of *M. jeffersoni* from

Rancho La Brea and other localities of Wisconsin age that are presently being studied by G. McDonald (personal communication 1975) at the University of Florida. The greatest distance across the articular facets for the astragalus is 79.4 mm. The minimum anteroposterior diameter at the neck of the calcaneum is 51.1 mm.

Six foot bones have been collected. A proximal phalanx (NMC 23042, Old Crow Locality 66), probably of the third digit, has a maximum length, width and height of 55.3 x 43.5 x 35.9 mm. A smaller proximal phalanx (NMC 22567, Old Crow Locality 11A), probably of the fourth digit, has badly damaged distal articular surfaces. Its maximum length and width are 43.8 x 36.3 mm. A second phalanx of the third digit (NMC 28550, Old Crow Locality 144) appears to be only slightly smaller in maximum length, width and height (74.9 x 39.8 x 52.1 mm.) than approximate measurements from a scaled figure of *Megalonyx jeffersoni* from Kentucky (79.2 x 35.0 x 57.2 mm.) illustrated by Leidy (1855, Plate X, Figures 4, 8). A penultimate phalanx (NMC 14883, Old Crow Locality 29), possibly of the second digit, is damaged proximally. Its maximum length and width are 53.1 x 30.8 mm. This specimen may articulate with an ungual phalanx of the second digit (NMC 14882, Old Crow Locality 29) which was collected at the same time and place. Its maximum height and width are 51.2 x 29.5 mm. A large ungual phalanx of the third digit of the manus (NMC 26193,

Old Crow Locality 11A) has maximum height and width measurements of 60.8 x 33.4 mm. The distal, hooked ends of these ungual phalanges are lacking.

Discussion

It is worth noting that the ground sloth specimens are derived from relatively few localities (11A, 22, 29, 66), which are situated near the mouths of the present major tributaries of the Old Crow River: Johnson, Black Fox and Timber creeks (Figure 2). Most of the specimens appear to be smaller than Wisconsin age *Megalonyx*, which may be due to: (a) the younger chronological age of the individuals represented; (b) the fact that there may be a size difference due to sex, in which case the Old Crow specimens would likely be females; (c) the fact that they represent ground sloths living before Wisconsin time. A definite increase in size of *Megalonyx* from early to late Pleistocene has been noted by Romer (1966, p. 295) and G. McDonald (personal communication 1975). Of these explanations, I prefer the last.

Ground sloths evolved in South America during the early Tertiary, and the Megalonychidae first appeared in the early Oligocene of Patagonia. Hirschfeld and Webb (1968, Figure 22) suggest that *Megalonyx* was derived from the *Pliomorphus* - *Ortotherium* complex of South American megalonychids in early Pliocene time. When the Panamanian

Isthmus was re-established in the late Pliocene, for the first time since the beginning of the Tertiary, various ground sloths prevailed against the tide of Nearctic mammals, and moved into Central and North America. *Megalonyx*, although never reported from South America, ranged widely through North America reaching as far north as the Yukon and Alaska. The genus shows a great deal of skeletal (particularly dental) plasticity; consequently, a revision of *Megalonyx* would likely result in a reduction of species.

An Alaskan specimen, a proximal phalanx possibly of the fourth digit of the manus (F:AM 30844), was the first indication that *Megalonyx* had reached Eastern Beringia (Stock 1942, p. 552). Apparently no other ground sloth specimens have been reported from Alaska. Soon afterward, a second lower molar (ANSP 15208) of *Megalonyx* cf. *jeffersoni* was collected at Lower Carp Lake north of Yellowknife in the Northwest Territories (Stock and Richards 1949, p. 709). It was associated with a fragment of American mastodon molar, suggesting a relatively warm forest or open forest habitat. Considered together, the Alaskan, Yukon and Northwest Territories records suggest that *Megalonyx* occupied a rather broad east-west range in northwestern North America during a warm phase of the late Pleistocene (Harington 1971a, p. 82).

The only other *Megalonyx* specimens reported from Canada are an ungual phalanx (cast; ROM 3339) from river gravels near Quesnel, British Columbia, an undescribed tooth fragment (ROM 5538) from near Saskatoon, Saskatchewan (C.S. Churcher, personal communication 1970), and other specimens from Wellsch Valley, Saskatchewan (Stalker 1971, p. 180) and Medicine Hat, Alberta (Stalker and Churcher 1970).

Megalonyx was a long-haired, bear-sized ground sloth. In the more southerly regions of North America it is associated with Pleistocene forest faunas. Its broad blunt caniniforms suggest a leaf-stripping adaptation (Hirschfeld and Webb 1968, p. 291). It would be interesting to know what kinds of trees or shrubs *Megalonyx* preferred. The fact that Old Crow specimens appear to be smaller than most Wisconsin age fossils may indicate that they reached northwestern North America during the Sangamon, or possibly an earlier interglacial. No radiocarbon dates on *Megalonyx* bone from Eastern Beringia are available, nor does biostratigraphic information provide a clue as to the period when these ground sloths lived in the arctic. Evidently *Megalonyx* became extinct about 9,400 years ago (Martin and Guilday 1967, p. 19).

Order Lagomorpha

Family Ochotonidae

Ochotona cf. *whartoni* (giant pika)

Referred specimens

Two mandible fragments with teeth (Figure 10A-B, Table 12) from Quaternary deposits in the Old Crow Basin represent very large or giant pikas. The first specimen, a left mandible fragment with LM_1-LM_3 (NMC 16817), was collected in 1967 at Old Crow Locality 14N. M_3 consists of one loop, as in the Ochotonidae. I first mentioned this specimen in a faunal list from that locality as "Ochotonidae - giant pika" (Irving and Harington 1973, p. 339). The teeth, according to size and degree of wear, seem to be those of an adult. The specimen is stained brown. Mary Dawson (personal communication 1970), who kindly examined NMC 16817, suggested that it is best considered to represent a species of *Ochotona*, although P_3, which is of diagnostic importance in this group, is lacking.

The second specimen, a left mandible with LM_1-LM_2 and part of the alveolus for LM_3 (NMC 24380), was collected in 1973 at Old Crow Locality 11A. It has the same general proportions as NMC 16817, but is slightly larger. Again, the size and degree of wear on the teeth indicate that it represents an adult. The large mental foramen below LM_2

Figure 10. Left mandibular fragment with LM_1-LM_3 of a Pleistocene giant pika *(Ochotona* cf. *whartoni)* (NMC 16817, Old Crow Locality 14N). A. Lateral view. B. Occlusal view. Left mandible with LP_3-LM_3 of a Pleistocene American pika *(Ochotona princeps)* (NMC 18563, Old Crow Locality 29). C. Lateral view. D. Occlusal view.

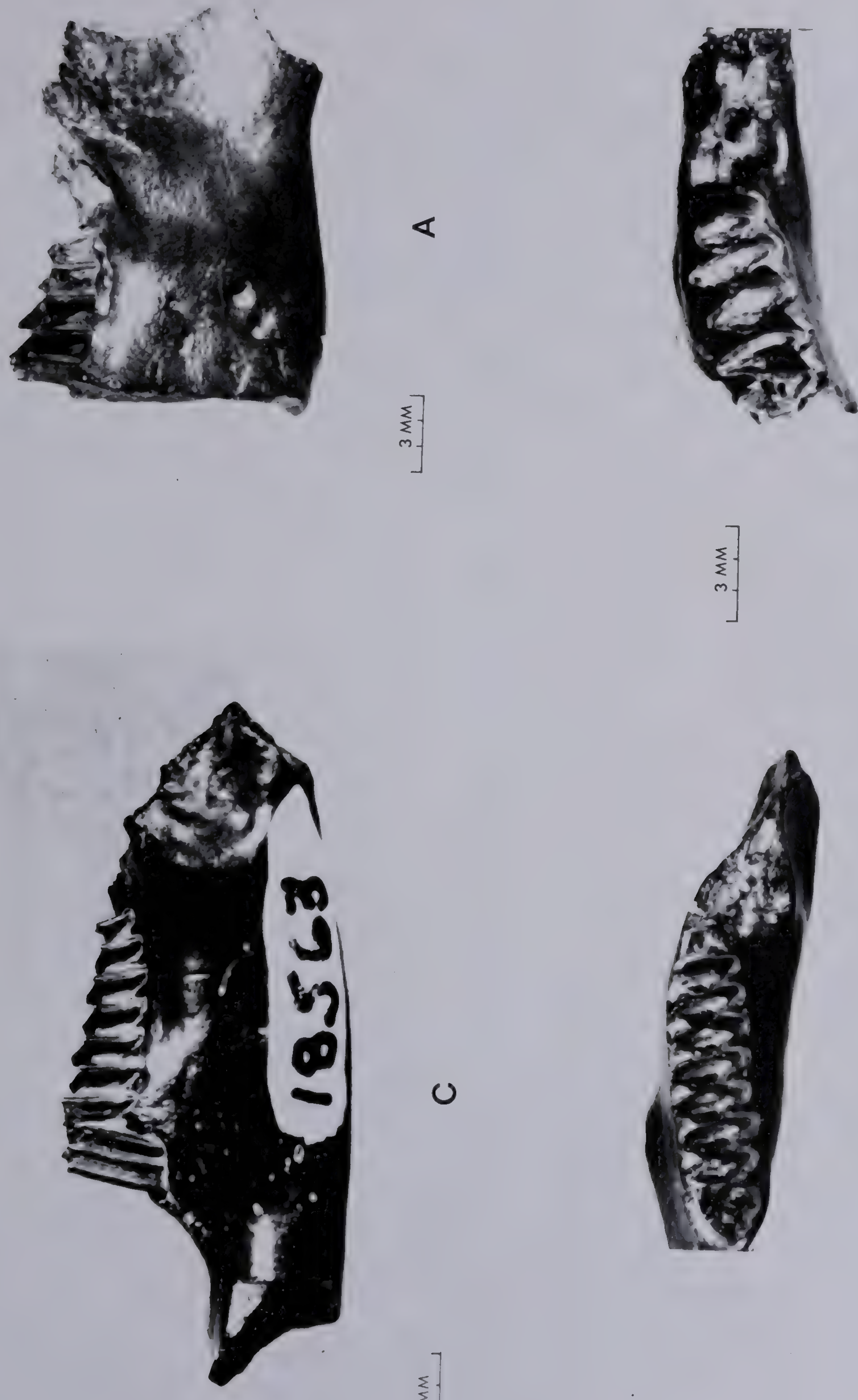

A
3 MM
B
3 MM
C
3 MM
D
18563

Table 12. Measurements of Pleistocene giant pika (*Ochotona* cf. *whartoni*) mandibles from the Yukon Territory compared to Pleistocene *O. whartoni* from Alaska.

Specimens	Measurements (mm)*							
	1	2	3	4	5	6	7	8
Ochotona cf. *whartoni*.Pleistocene, Y.T.								
NMC 16817 Old Crow Loc. 14N	9.9	9.5	2.3+	2.8	2.9	2.8	1.7	2.0
NMC 24380 Old Crow Loc. 11A	10.5	-	3.1	3.0	3.2	2.9	-	-
Ochotona whartoni.Pleistocene, Alaska								
UA 2000 Cape Deceit**	9.9	-	3.0	2.8	2.9	2.6	-	-
F:AM 101149 Gold Hill (Fairbanks Area)	9.3	7.9***	2.1	2.4	2.1	2.3	1.0	1.6

* 1 - Mandible depth below centre of M_1.
2 - Minimum mandible depth from posterior of M_3 to the concavity on the lower surface of the mandible.
3 - Length (anteroposterior) M_1.
4 - Width M_1.
5 - Length M_2.
6 - Width M_2.
7 - Length M_3.
8 - Width M_3.

** I am grateful to R.D. Guthrie of the University of Alaska for supplying these measurements.

*** Mandible depth taken below M_3 as the mandible is broken behind this tooth. John H. Wahlert of the American Museum of Natural History kindly provided the measurements on the specimen from Gold Hill, Alaska.

and other traces of foramina nearby are like those of NMC 16817 and are correct for *Ochotona*. A large cavity on the inside of the mandible is due to erosion of the thin bone near the swelling at the root of the incisor. Such cavities are not uncommon in fossil pika mandibles (e.g. *Ochotona princeps*; NMC 15834); one exists in the holotype of *Ochotona whartoni* (Guthrie and Matthews 1971, p. 499), a Pleistocene giant pika from Alaska. NMC 24380 is stained dark reddish brown.

Discussion

In 1971 Guthrie and Matthews described a partial mandible of a large pika with RM_1-RM_2 (UA 2000) from the Cape Deceit Formation (?Nebraskan) on Kotzebue Sound, Alaska as the holotype of a new species *Ochotona whartoni*. Two complete maxillary tooth rows, jaw fragments and incomplete molars from that formation were referred to this species, as was a relatively complete skull with mandibles (F:AM 101149) from Gold Hill Cut in the Fairbanks area of Alaska, which is in the collections of the American Museum of Natural History. It should be emphasized that the teeth of this specimen are much smaller than those of *O.* cf. *whartoni* from the Yukon Territory, and that they are similar in size to large fossils from that region referred to *O. princeps*. *O. whartoni* was differentiated on the basis of its large size, which, although seemingly practical in this case, is

rather a tenuous criterion - especially when some species of Pleistocene pikas are known to vary in size. For example, it is important to note size variations in the Sardinian pika *Prolagus sardus*: postglacial forms average 15 to 20% larger than the middle Pleistocene ones (Kurtén 1968, p. 227). Size also differs between modern *O. princeps* and Old Crow Pleistocene pika specimens that I attribute to *O. princeps*. If better specimens of the giant pika are found in Yukon Pleistocene deposits, it may be possible to identify them more precisely. Meanwhile, I consider that the fossils NMC 16817 and 24380 are most closely comparable to *Ochotona whartoni* and may be referred to *Ochotona* cf. *whartoni*. These fossils are markedly larger than any specimens of Recent *O. princeps* that I have seen, and probably larger than any living pikas of Asia (M.R. Dawson, personal communication 1970). Unfortunately, specimens of some large Pleistocene pikas from China (e.g. *O. koslowi* and *Ochotonoides complicidens*) were not available for comparison with the Yukon fossils. In overlaying NMC 16817 on a natural sized illustration of *Ochotonoides complicidens* (Teilhard de Chardin and Young 1931, Plate VI, 4), both specimens are seen to be of similar size but the mandible of the Yukon specimen is less deep, particularly posterior to M_3. "*O. daurica*", from the Pleistocene deposits of Gezidong Cave, China (Archaeological Team of the Provincial

Museum of Liaoning 1975, p. 129, Figure 10), also appears to be similar in size to the Yukon fossils.

Alaskan specimens of *O. whartoni* indicate that giant pikas lived in Eastern Beringia from early to middle Pleistocene time, for the fossil from Gold Hill, which is slightly smaller than those from Cape Deceit, may be of Illinoian age (Péwé 1975b, p. 12). Because of their dark staining, I suggest that Old Crow specimens are pre- late Wisconsin, perhaps early Pleistocene in age. They cannot be firmly dated because they were not found in place.

Some comments on the evolutionary history of the pikas are given in the section on *Ochotona princeps*. The "blossoming" of large pikas, like those mentioned above, in the early to middle Pleistocene of China is remarkable. Perhaps this influence extended in Nebraskan time to Cape Deceit, Alaska, and later (Illinoian?) to the Fairbanks area of Alaska and the Old Crow Area of the Yukon Territory. Guthrie (1973) gives evidence that *O. princeps*, considered a member of the alpine fauna, had spread into the lowlands of central Alaska during the late Pleistocene and occupied a drier more steppe-like environment than now prevails there. Shifts of habitat such as this could be largely responsible for variations in size that are seen among

fossils from the Old Crow Basin. I postulate that *Ochotona* cf. *whartoni* occupied a relatively rich steppe grassland habitat in Eastern Beringia during the early to middle Pleistocene. Being approximately twice the size of the living American pika, it may have benefited from access to more abundant lowland forage.

Ochotona princeps (American pika)

More than 80 specimens (Figure 10C-D, Table 13-14) of the American pika have been collected from Pleistocene deposits in the Old Crow Basin. Most are mandibular fragments with teeth (only three are maxillary fragments), which lack the ascending ramus and complete diastema. Unless otherwise specified, all specimens are stained brown.

Referred specimens

NMC 19102 is a right maxillary fragment with RP^3-RM^2 and part of the alveolus for RP^2. The facial tubercle and part of the palate are preserved. The fossil is stained black, and was excavated from oxidized sandy gravel overlying the basal clay unit at Old Crow Locality 28. NMC 19109 is a right maxillary fragment with RP^3-RM^1 and part of the alveolus for RP^2. It also includes the facial tubercle and part of the right side of the palate. It is stained black and was also excavated at Old Crow Locality 28. NMC 25358 from Old

Table 13. Measurements of Pleistocene pika *(Ochotona princeps)* maxillae from the Yukon Territory compared to those of Recent North American pikas.

SPECIMENS	SEX	MEASUREMENTS (mm)*							
		1	2	3	4	5	6	7	8
Ochotona princeps. Pleistocene, Old Crow Area, Y.T.									
NMC 19102 Loc. 28	-	1.4	2.6	1.9	3.0	1.8	2.9	1.9	2.3
NMC 19109 Loc. 28	-	1.7	3.1	2.0	3.1	1.8	2.7	-	-
NMC 25358 Loc. 27W	-	-	-	1.8	3.2	-	-	-	-
Ochotona princeps. Recent,									
NMC 31162 Yukon Territory	♂	1.4	2.7	1.7	2.7	1.6	2.6	1.7	2.3
NMC 31172 Yukon Territory	♂	1.2	2.3	1.5	2.4	1.6	2.3	1.5	2.2
NMC 31173 Yukon Territory	♀	1.2	2.6	1.5	2.5	1.6	2.5	1.4	2.5
NMC 31166 Yukon Territory	♂	1.1	2.5	1.3	2.5	1.4	2.3	1.5	2.2
NMC 40302 Alaska	♂	1.2	2.4	1.5	2.6	1.7	2.6	1.6	2.4
NMC 31170 Yukon Territory	♀	1.2	2.4	1.4	2.6	1.4	2.3	1.4	2.3

* 1- Length (anteroposterior diameter) P^3. 2. Width P^3. 3. Length P^4. 4. Width P^4. 5. Length M^1. 6- Width M^1. 7. Length M^2. 8. Width M^2.

Table 14. Measurements of Pleistocene pika *(Ochotona princeps)* mandibles from the Yukon Territory compared to those of Recent North American pikas.

SPECIMENS	SEX	MEASUREMENTS (mm) *															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Othotona princeps, Pleistocene, Old Crow Area, Y.T.																	
NMC 19241 Loc. 44	-	-	3.9	8.5	5.4†	6.3	5.9	1.6	1.6	2.0	1.9	2.0	2.1	2.0	2.1	1.0	1.6
NMC 22256 Loc. 27W	-	34.0	4.3	9.7	8.3	6.7	6.4	-	-	1.8	1.9	2.0	2.1	2.1	2.1	1.2	1.3
NMC 22267 Loc. 27W	-	-	4.0	7.7	-	6.6	-	1.8	1.7	2.0	2.0	2.0	2.1	2.0	2.1	-	-
NMC 22163 Loc. 27W	-	-	4.7	6.8	8.9	6.4	6.7	1.6	1.7	2.1	2.0	2.2	1.9	2.2	2.2	1.1	1.5
NMC 18563 Loc. 29	-	-	4.3	6.1†	9.3	6.7	7.1	-	-	-	-	-	-	-	-	-	-
NMC 22264 Loc. 27W	-	-	-	-	-	6.3	6.1	-	-	-	-	2.0	2.1	2.1	2.3	1.0	1.5
NMC 18368 Loc. 29	-	-	-	-	-	6.5	6.1	-	-	2.0	2.0	2.1	2.0	2.1	1.9	-	-
NMC 24741 Loc. 11A	-	-	-	6.2†	9.7	7.0	6.9	-	-	2.1	2.1	1.9	2.1	2.0	2.1	1.1	1.2
NMC 22266 Loc. 27W	-	-	4.5	5.1†	10.2	7.8	7.0	-	-	-	-	-	-	-	-	-	-
NMC 15713 Loc. 28	-	-	-	-	-	-	-	-	-	2.0	2.1	2.2	2.3	2.1	2.1	1.2	1.4
NMC 24673 Loc. 22	-	-	-	10.0	-	7.4	6.9	-	-	2.1	2.2	2.3	2.3	2.3	2.2	1.2	1.8
NMC 25313 Loc. 27W	-	-	-	-	-	7.3	7.0	-	-	2.1	2.0	2.1	2.1	2.1	2.2	1.1	1.5
NMC 22208 Loc. 27W	-	-	-	-	-	6.5	6.2	-	-	2.0	2.1	2.1	2.0	2.0	2.3	-	-
NMC 22240 Loc. 27W	-	-	-	10.2	-	7.8	6.1	-	-	2.0	2.4	2.1	2.2	2.2	2.2	-	-
NMC 22231 Loc. 27W	-	-	-	-	-	6.9	6.6	-	-	1.9	2.2	1.9	2.3	2.1	2.2	1.0	1.4
NMC 25489 Loc. 44	-	-	-	-	-	7.0	6.5	-	-	1.9	2.0	2.1	2.0	2.0	1.9	1.0	1.2
NMC 22268 Loc. 27W	-	-	-	-	-	7.0	6.6	-	-	-	-	2.0	2.2	1.9	2.3	1.1	1.7
NMC 18269 Loc. 27W	-	-	-	-	-	7.8	7.3	-	-	2.1	2.1	2.2	2.2	2.3	2.1	1.0	2.0
NMC 22265 Loc. 27W	-	-	4.1	-	7.3	6.6	-	-	-	-	-	2.0	2.1	1.9	2.0	-	-
NMC 18224 Loc. 11A	-	-	-	9.3	-	7.0	6.7	1.7	1.6	2.2	2.0	1.8	2.0	1.8	2.0	1.0	1.5
NMC 22052 Loc. 27W	-	-	4.2	9.8	7.4	6.8	6.5	-	-	2.2	2.2	1.9	2.2	2.1	2.1	-	-
NMC 25053 Loc. 22	-	-	-	9.5	-	7.0	6.8	-	-	2.1	2.0	2.0	2.1	2.0	2.0	0.9	1.5
NMC 22161 Loc. 27W	-	-	5.2	10.1	7.8†	8.0	7.5	-	-	2.0	1.9	2.1	2.2	1.8	2.0	1.1	1.7
NMC 22167 Loc. 27W	-	-	4.3	9.8	6.0	7.4	7.0	-	-	1.9	2.1	1.9	2.2	2.1	2.3	1.2	1.5
NMC 22166 Loc. 27W	-	-	4.2	9.6	8.0	7.2	-	2.0	1.7	2.1	2.0	2.2	2.3	2.3	-	-	-
NMC 18636 Loc. 27	-	-	4.4	9.0	5.5†	5.8	5.3	-	-	-	-	-	-	-	-	-	-
NMC 18635 Loc. 27	-	-	4.1	9.1	7.0	6.8	6.0	-	-	2.0	2.0	2.0	2.1	1.8	2.1	1.0	1.4
NMC 25305 Loc. 27W	-	-	-	-	-	-	6.8	-	-	-	-	-	-	1.9	2.1	-	-
NMC 22241 Loc. 27W	-	-	3.8	9.1	7.2	6.6	6.3	-	-	1.9	1.7	2.0	2.0	1.9	2.0	1.0	1.4
NMC 18568 Loc. 29	-	-	-	-	-	8.3	7.1	-	-	2.2	2.3	2.2	2.4	2.2	2.3	1.0	1.8
NMC 18559 Loc. 29	-	-	4.7	9.4	5.8†	7.1	6.6	-	-	2.2	1.9	2.0	2.0	2.0	2.0	1.0	1.5
NMC 25303 Loc. 27W	-	-	-	-	-	6.6	-	-	-	2.0	2.0	2.2	2.0	-	-	-	-
NMC 22245 Loc. 27W	-	-	-	-	-	6.9	-	-	-	2.1	2.0	2.0	2.0	2.1	2.0	-	-
NMC 22279 Loc. 27W	-	-	-	-	-	7.2	6.8	-	-	-	-	-	2.0	1.9	2.0	0.9	1.5
NMC 24792 Loc. 45	-	-	-	-	-	-	6.6	-	-	-	-	-	-	2.0	2.1	1.0	1.8
NMC 22189 Loc. 27W	-	-	4.3	-	8.1	-	-	-	-	-	-	-	-	-	-	-	-
NMC 25291 Loc. 27W	-	-	-	-	-	6.7	-	-	-	-	-	2.1	1.9	1.8	1.7	-	-
NMC 15831 Loc. 44	-	-	-	8.3	-	6.0	5.6	-	-	1.6	1.8	1.6	1.9	1.5	1.8	-	-
NMC 15833 Loc. 44	-	-	-	9.4	7.0	7.0	6.2	-	-	1.8	2.0	2.0	2.1	2.1	2.0	-	-
NMC 15830 Loc. 44	-	-	-	-	-	-	5.7	-	-	-	-	-	-	1.7	1.7	0.8	1.3
NMC 15834 Loc. 44	-	-	-	9.2	-	6.8	6.5	-	-	2.0	2.0	1.9	2.1	1.9	2.1	1.0	1.4
NMC 15835 Loc. 44	-	-	-	-	-	6.9	7.2	-	-	1.9	2.1	2.1	2.0	2.0	2.1	1.1	1.5
NMC 15832 Loc. 44	-	-	-	9.7	-	6.7	6.0	-	-	1.9	2.0	2.1	2.0	1.9	2.0	1.0	1.5
NMC 15831 Loc. 44	-	-	-	-	-	-	6.2	-	-	-	-	-	-	1.9	1.8	-	-
NMC 15633 Loc. 28	-	-	-	9.1	-	6.1	5.6	-	-	1.7	2.0	1.8	2.0	1.9	1.9	0.9	1.3
NMC 20740 Loc. 44	-	-	3.7	8.6	7.1	6.6	6.0	-	-	1.9	1.9	2.0	2.1	1.8	1.8	1.1	1.2
NMC 18776 Loc. 20	-	-	-	8.7	-	6.2	6.1	-	-	1.7	2.0	1.8	2.1	1.7	2.0	0.9	1.4
NMC 22061 Loc. 27W	-	-	2.7	-	4.8	5.3	-	-	-	1.5	1.6	1.5	1.6	-	-	-	-
NMC 25488 Loc. 44	-	-	-	-	-	5.9	-	-	-	-	-	1.9	2.1	1.7	2.1	-	-
NMC 22162 Loc. 27W	-	-	-	9.2	6.1†	7.1	6.9	-	-	1.9	2.0	2.0	2.1	1.9	2.0	1.2	1.5
NMC 25487 Loc. 44	-	-	-	-	-	-	-	-	-	-	-	-	-	1.8	1.8	-	-
NMC 22247 Loc. 27W	-	-	-	-	-	6.8	6.5	-	-	2.2	2.2	1.9	2.1	1.9	2.1	0.9	1.5
NMC 24790 Loc. 45	-	-	-	-	-	5.6	6.2	-	-	-	-	-	1.9	1.8	1.9	1.0	1.5
NMC 24893 Loc. 11A	-	-	-	6.7	-	4.4	4.7	-	-	-	-	1.5	1.5	1.5	1.4	-	-
NMC 22276 Loc. 27W	-	-	-	-	-	6.9	6.6	-	-	-	-	2.0	2.4	1.8	2.0	1.1	1.6
NMC 22242 Loc. 27W	-	-	3.6	9.3	6.0	6.4	6.0	-	-	2.0	1.8	2.1	1.9	2.0	2.0	-	-
NMC 25284 Loc. 27W	-	-	-	-	-	-	6.0	-	-	-	-	-	1.9	1.7	2.0	-	-
NMC 24895 Loc. 11A	-	-	3.6	8.8	5.3	5.5	-	-	-	-	-	1.8	1.8	-	-	-	-
NMC 22215 Loc. 27W	-	-	-	-	-	5.7	6.0	-	-	-	-	1.7	1.9	1.6	2.0	-	-
NMC 22193 Loc. 27W	-	-	-	-	-	6.0	5.8	-	-	1.8	1.9	1.7	2.0	1.5	2.0	0.9	1.4
NMC 25277 Loc. 27W	-	-	-	-	-	5.6	-	-	-	1.6	1.6	1.6	1.7	1.7	1.6	-	-
NMC 22205 Loc. 27W	-	-	-	-	-	6.6	6.5	-	-	-	-	2.1	2.0	1.9	2.1	1.0	1.5
NMC 22140 Loc. 27W	-	-	-	-	-	-	6.2	-	-	-	-	-	-	2.0	2.0	1.1	1.8
NMC 22174 Loc. 27W	-	-	-	-	-	5.0	4.8	-	-	-	-	1.4	1.5	1.3	1.6	0.6	1.1
NMC 16646 Loc. 27	-	-	-	7.5	-	5.0	4.8	-	-	1.6	1.5	1.6	1.5	1.7	1.6	0.8	1.0
NMC 22135 Loc. 27W	-	-	2.7	-	3.9†	4.2	-	-	-	-	-	1.4	1.4	-	-	-	-
NMC 28666 Loc.137	-	-	4.0	9.1	-	6.6	6.4	-	-	1.8	1.9	2.1	2.0	2.2	2.0	1.1	1.4
NMC 28709 Loc. 27	-	-	-	9.0	-	5.9	6.3	-	-	1.8	2.0	1.9	2.0	2.1	2.0	1.2	1.5
NMC 28553 Loc. 22	-	-	-	9.3	-	6.2	6.1	-	-	1.9	1.8	1.9	1.9	1.8	1.9	1.1	1.4
NMC 28700 Loc. 22	-	-	-	9.5	6.3	7.4	6.9	-	-	2.0	2.1	2.2	2.1	2.1	2.1	1.1	1.5
NMC 28640 Loc. 65	-	-	-	-	-	-	7.6	-	-	-	-	-	-	-	-	1.2	1.6
NMC 28768 Loc.104	-	-	-	-	-	7.1	7.6	-	-	-	-	-	2.1	2.2	2.1	1.2	1.5
NMC 28733 Loc. 27	-	-	-	-	-	-	7.0	-	-	-	-	-	-	2.1	2.0	1.2	1.6
Ochotona princeps, Recent																	
NMC 31162 Yukon Territory	♂	27.8	3.6	8.1	5.7	6.3	5.3	1.4	1.5	1.7	1.8	1.9	1.9	1.8	1.9	1.0	1.3
NMC 31172 Yukon Territory	♂	28.5	3.2	8.0	5.8	5.3	5.0	1.4	1.5	1.6	1.7	1.8	1.7	1.6	1.8	0.8	1.3
NMC 31173 Yukon Territory	♀	27.1	3.6	7.4	6.7	5.2	5.0	1.5	1.5	1.6	1.8	1.8	1.9	1.7	1.8	0.8	1.4
NMC 31166 Yukon Territory	♂	28.0	3.5	7.0	6.5	5.2	5.3	1.3	1.4	1.5	1.8	1.6	1.8	1.6	1.7	0.8	1.2
NMC 40302 Alaska	♂	27.4	3.5	7.6	6.2	5.3	5.0	1.4	1.4	1.6	1.8	1.9	1.8	1.9	1.8	0.9	1.2
NMC 31170 Yukon Territory	♀	27.8	3.2	7.5	6.6	5.3	4.9	1.4	1.6	1.6	1.7	1.6	1.7	1.8	1.8	0.8	1.2

* 1 - Mandible length (superior alveolar margin of I_1 to posterior of angle).
2 - Diastema depth.
3 - Alveolar length (P_3-M_3).
4 - Diastema length (superior alveolar margin of I_1 to anterior alveolar margin of P_3.
5 - Mandible depth (M_1).
6 - Mandible depth (posterior of M_3).
7 - Length P_3.
8 - Width P_3.
9 - Length P_4.
10 - Width P_4.
11 - Length M_1.
12 - Width M_1.
13 - Length M_2.
14 - Width M_2.
15 - Length M_3.
16 - Width M_3.

Crow Locality 27W is a right maxillary fragment with RP^4 which is joined by alveolar bone to the facial tubercle.

NMC 19241 is a right mandibular fragment with RP_3-RM_3 and a broken incisor. P_3 rises vertically, rather than curving back near the occlusal surface as in a Recent specimen from the Yukon Territory (NMC 31162). The fossil was excavated from organic sandy gravel overlying the basal clay unit at Old Crow Locality 44. NMC 22256, a left mandible from Old Crow Locality 27W, is complete except for LP_3 and a tip of the angular process. The anterior mandibular foramen is well developed. NMC 22163 from Old Crow Locality 27W is a right mandibular fragment with RP_3-RM_3. NMC 18563, a left mandible with LP_3-LM_3, excavated from Old Crow Locality 29, is stained blackish brown. The bone has eroded to form a cavity on the inside of the mandible near the incisor root. NMC 22266 from Old Crow Locality 27W is a right mandible with RP_4-RM_3 and the alveolus for RP_3. It is stained black. NMC 18559 from Old Crow Locality 29 is a left mandible with LP_4-LM_3. NMC 20740, a left mandible containing LP_4-LM_3 and the alveolus of LP_3, was excavated at Old Crow Locality 44. NMC 24741 is a right mandible with RP_4-RM_3 and the alveolus for RP_3. It is from gravel deposits on a bar, Old Crow Locality 11A. NMC 28666 is a left mandible with LP_4-LM_3 and the alveolus for LP_3. NMC 18224

from Old Crow Locality 11A is a left mandible with LP_3-LM_3. It is stained dark brown with mottled oxidation specks on the lateral surface. NMC 22052 from Old Crow Locality 27N is a left mandible with LP_4-LM_2 and alveoli for the incisor, LP_3 and LM_3. It is stained reddish brown. NMC 22161 from Old Crow Locality 27W is a left mandible with LP_4-LM_3 and the alveolus for LP_3. It is stained dark brown on the inside and has a mottled dark and light brown surface on the outside. NMC 22167 from Old Crow Locality 27W is a right mandible with RP_4-RM_3 and the alveolus for RP_3. It is stained blackish brown. NMC 22241 from Old Crow Locality 27W is a left mandible with LP_4-LM_3 and the alveolus of LP_3. NMC 18636 from Old Crow Locality 27W is a right mandible with RP_4-RM_2 and alveoli for RP_3 and RM_3. It has a relatively shallow mandible compared to most fossils from the Old Crow Basin. It is comparable in this respect to a Recent specimen from the Yukon (NMC 31162). NMC 22267 is a right mandible with RP_3-RM_2. It is stained dark reddish-brown and was excavated at Old Crow Locality 27W. NMC 25053 from Old Crow Locality 22 is a left mandible with LP_4-LM_3 and the alveolus for LP_3. NMC 22166 from Old Crow Locality 27W is a right mandible with RP_3-RM_2 and the alveolus for RM_3. NMC 15834 is a right mandible with RP_4-RM_3 and the alveolus for RP_3. It was excavated from organic sandy gravel overlying the basal clay unit at Old Crow

Locality 44. NMC 15832, a left mandible with LP_4-LM_3 and the alveolus for LP_3, was excavated at Old Crow Locality 44. NMC 15633 from Old Crow Locality 28 is a right mandible with RP_4-RM_3 and the alveolus for RP_3. NMC 18776 from Old Crow Locality 20 is a left mandible with LP_4-LM_3 and the alveolus for LP_3. NMC 22162 from Old Crow Locality 27W is a right mandible with RP_4-RM_3 and the alveolus for RP_3. NMC 22242 from Old Crow Locality 27W is a left mandible with LP_4-LM_2 and alveoli for LP_3 and LM_3. NMC 18646 from Old Crow Locality 27 is a left mandible with LP_4-LM_3 and the alveolus for LP_3. NMC 28709 from Old Crow Locality 27 is a left mandible with LP_4-LM_3 and the alveolus for RP_3. NMC 28700 from Old Crow Locality 27 is a right mandible with RP_4-RM_3 and the alveolus for RP_3.

NMC 22247, a right mandible with RP_4 (fragmentary) -RM_3, is stained black. It is from Old Crow Locality 27W. NMC 22193 from Old Crow Locality 27W is a right mandible with RP_4-RM_2. It is stained black. NMC 15833, a right mandible with RP_4-RM_2 and the alveolus of RM_3, was excavated at Old Crow Locality 44. NMC 18269 from Old Crow Locality 27W is a left mandible with LP_4-LM_3. NMC 25489, a right mandible with RP_4-RM_3, is stained dark brown with traces of oxidation on the outside below RP_4. The specimen was excavated at Old Crow Locality 44. NMC 22231 from Old Crow

Locality 27W is a right mandible with RP_4-RM_3. A cavity on the inside of the mandible resulted from breakage of bone at a swelling near the root of the incisor. This swelling is characteristic of both giant pikas *(O.* cf. *whartoni)* and *O. princeps*. NMC 25313 from Old Crow Locality 27W is a right mandible with RP_4-RM_3. The mandible of this specimen is deep compared to that of a Recent Yukon pika (NMC 31162). NMC 24673 from Old Crow Locality 22 is a right mandible with RP_4-RM_3 and the alveolus for RP_3. It is stained black. NMC 15713 from Old Crow Locality 28 is a right mandible with RP_4-RM_3. It is a mottled brown color. NMC 18635 is a right mandible with RP_4-RM_3 with the alveolus for RP_3 and a complete diastema. It was collected at Old Crow Locality 27. NMC 18568 from Old Crow Locality 29 is a left mandible with LP_4-LM_3. It has a relatively deep mandible, but the teeth are smaller than those of *O.* cf. *whartoni*.

NMC 22240 from Old Crow Locality 27W is a right mandible with RP_4-RM_2 and alveoli for RP_3 and RM_3. NMC 15831 from Old Crow Locality 44 is a right mandible with RP_4-RM_2 and alveoli for RP_3-RM_3. The bone is thin, and RP_4 roots penetrate the ventrolateral wall of the mandible. Presumably the animal represented was immature at death. The specimen is stained light reddish brown as if its matrix were oxidized. NMC 15835 from Old Crow Locality 44 is a

right mandible with RP_4-RM_3. The swelling in the bone near the medial side of the incisor root is broken. NMC 25277 from Old Crow Locality 27W with LP_4-LM_2 is relatively small and is stained dark reddish brown. NMC 22174 is a left mandible with LM_1-LM_3. It is from Old Crow Locality 27W, and is smaller than NMC 25277. NMC 22264 from Old Crow Locality 27W is a left mandible with LM_1-LM_3. The anterior half of the ascending ramus is preserved. The specimen is stained black. NMC 22208, a right mandible with RP_4-RM_2, was excavated at Old Crow Locality 27W. It is stained black. NMC 18368 from Old Crow Locality 29 is a right mandible with RP_4-RM_2 and alveoli for RP_3 and RM_3. The bony swelling near the medial side of the incisor root is broken. NMC 22268 from Old Crow Locality 27W is a left mandible with LM_1-LM_3 and partial alveoli for LP_3 and LP_4. NMC 22265, a left mandible with LM_1-LM_2 and alveoli for the premolars, is stained dark reddish brown. It was excavated from organic sandy gravel overlying the basal clay unit at Old Crow Locality 27W. NMC 22061 from Old Crow Locality 27W is a right mandible with RP_4-RM_1 and alveoli for the remaining cheek teeth. It is stained dark reddish brown. The unusually small size of this specimen suggests that a young individual is represented. NMC 24790 is a right mandible with RM_1-RM_3. The posterior of RM_1 is damaged. The specimen was excavated from sandy silt about 30 feet

(9.1 m) above the level of the Old Crow River at Locality 45. These sediments may be of late Sangamon or early Wisconsin age. NMC 22276 from Old Crow Locality 27W is a left mandible with LM_1-LM_3. The teeth are heavily worn, which may account for their relatively large size. The specimen is stained black. NMC 24893 from Old Crow Locality 11A is a right mandible with RM_1-RM_2 and alveoli for the remaining cheek teeth. The specimen is very small and may represent a juvenile. It is stained reddish brown. NMC 25277 from Old Crow Locality 27W is a left mandible with LP_4-LM_2. It is stained dark reddish brown. NMC 22140 from Old Crow Locality 27W is a left mandible with LM_2-LM_3 and the alveolus for LM_1. The teeth are well worn indicating that the individual represented was adult. The specimen has a mottled brown color.

NMC 28768 from Old Crow Locality 104 is the posterior part of a right mandible with the posterior loop of RM_1 and RM_2-RM_3. The mandible is relatively deep. NMC 24895 is a left mandible with LM_1 and alveoli for the remaining cheek teeth. It is from Old Crow Locality 11A. NMC 22215 from Old Crow Locality 27W is a right mandible with RM_1-RM_2 and the alveolus for RM_3. The specimen is stained black. NMC 22279, a left mandible with LM_1-LM_3, is from Old Crow Locality 27W. LM_1 is damaged. NMC 22245

from Old Crow Locality 27W is a left mandible with LP_4-LM_2 and the alveolus of LM_3. NMC 28733 from Old Crow Locality 27 is a right mandible with RM_2-RM_3. RM_1 is broken off at the alveolar margin. The specimen is stained blackish brown. NMC 22135 from Old Crow Locality 27W is a right mandible with RM_1 and alveoli for RP_3 and RP_4. Its small size may indicate that a young individual is represented. NMC 25488, a right mandible with RM_1-RM_2 and the alveolus for RM_3, was excavated at Old Crow Locality 44. NMC 15830 from the same site is a right mandible with RM_2-RM_3. The mandible anterior to RM_2 is lacking. The anterior half of the ascending ramus is preserved. The bone appears to be thin and fragile, suggesting that a young individual is represented.

NMC 25291 from Old Crow Locality 27W is a left mandible with LM_1-LM_2. NMC 24792 is a left mandible with LM_2-LM_3. It was collected from sandy silt about 30 feet (9.1 m) above the level of the Old Crow River at Locality 45. The enclosing sediments may be of Sangamon or early Wisconsin age. NMC 25303 from Old Crow Locality 27W is a left mandible with LP_4-LM_2 and the alveolus for RP_3. It is stained black. NMC 25284 from Old Crow Locality 27W is a right mandible with RM_1-RM_2 and the alveolus for RM_3. RM_1 is damaged. NMC 28649 is the posterior part of a right

mandible with damaged RM_2 and complete RM_3. This specimen from Old Crow Locality 65 was excavated from oxidized silty sands overlying the basal clay unit. NMC 15831 from Old Crow Locality 44 is a left mandible with LM_2 and alveolus for LM_3. NMC 22189 from Locality 27W is a left mandible with partial LP_4 and the alveolus for LP_3. It is stained dark reddish brown. NMC 25487 from Old Crow Locality 44 is a right mandible with RM_2 and the alveolus for RM_3.

A left humerus (NMC 22042) from Old Crow Locality 27W is slightly longer (29.3 mm) than that of a Recent male from the Whitehorse area of the Yukon (NMC 31162 - 27.0 mm).

Discussion

Pika fossils from Pleistocene deposits of the Old Crow Basin, although slightly larger on the average than Recent *Ochotona princeps collaris* specimens from the Yukon Territory I have seen, appear to differ in no other features. They are therefore referred to the American pika, *O. princeps*. Specimens collected *in situ* from the fossiliferous layer (Unit 2) at Old Crow Locality 44 indicate that *O. princeps* occupied the Old Crow Basin during the ?Sangamon interglacial (or earlier, if they are reworked

from older deposits). Specimens collected from sandy silt pockets above the fossiliferous unit at Localities 44 and 45 suggest that the pikas survived in the region at least to late ?Sangamon or early Wisconsin time. The Old Crow Basin is just northwest of the present range of *Ochotona princeps collaris*, as mapped by Youngman (1975, p. 55). Presumably the fossils indicate that pikas occupied scree areas on the margins of the Old Crow Basin during the late Pleistocene, although they may have been able to spread to lower areas, as Guthrie (1973, p. 970) has indicated for Alaska. The abundance of fossils suggests that pikas were common in the Old Crow Area during the late Pleistocene. *Ochotona* has not been reported previously from Pleistocene deposits in Canada.

The only specimens of the American pika recorded from Alaskan Pleistocene deposits are a mummified carcass from a placer operation near Chatanika in the Fairbanks area, and pika fecal pellets from detritus covered by 50 feet (15.2 m) of muck in the Wilber Creek area (Guthrie 1973, p. 970). The pellets and carcass are probably of Wisconsin age.

Of the 10 living lagomorph genera, nine belong to the family Leporidae (rabbits and hares). The pika *Ochotona*

is the only Recent representative of the Family Ochotonidae. However, this proportion was much different in the earlier Cenozoic. In the Miocene, for example, 13 of 18 genera of lagomorphs were ochotonids and only four were leporids.

The late Miocene presence of *Bellatona*, probably near the ancestral line, in central Asia suggests an Asian origin for *Ochotona*. The genus *Ochotona* first appears in the early Pliocene of Asia. By late Pliocene (Hemphillian) time it had crossed to North America, as documented by a record of *Ochotona spanglei* from Oregon (Shotwell 1956), and it had spread to Europe. *Ochotona* lived throughout the Pleistocene to the present interglacial in Eurasia and North America (Dawson 1967, p. 289-295).

In addition to the Yukon-Alaska region, pikas occurred in southern North America during the late Pleistocene. Remains from caves in the Appalachians are of particular interest. *Ochotona* has been reported from Cumberland Cave, Maryland, the lower levels of Trout Cave, West Virginia (both Illinoian age deposits), and from Rapps Cave, West Virginia (which is presently undated). Evidently *Ochotona* became extinct in the Appalachians before the Wisconsin glaciation, for it has not been found as yet in deposits of that period (Guilday 1971, p. 241). Pika fossils have also

been reported from caves in the northwestern United States. For example, remains of at least 19 individuals are recorded from Wilson Butte Cave, Idaho, and a single specimen is known from Jaguar Cave in the same state (Guilday 1969, p. 50; Guilday and Adam 1967, p. 32). Remains of at least 82 individual pikas *(O. princeps)* are recorded from the late Pleistocene deposits of Little Box Elder Cave, Wyoming (Anderson 1968, p. 11). Thus, from what seems to have been a much broader range during Illinoian time, it appears that *O. princeps* subsequently withdrew to scree in the North American Cordillera.

It is interesting to consider briefly the possible relationships among living Siberian, Yukon-Alaskan and more southern North American pikas. The steppe pika *(Ochotona pusilla)*, a rather small form, now ranges from the Volga to western Siberia. It tends to occupy brushy valleys, where it lives on grasses and herbs. Unlike the American pika *(O. princeps)*, it is nocturnal (Kurtén 1968, p. 227). Vorontsov and Ivanitskaya (1973) have indicated a close relationship between these two species, which have the same chromosomal count. Broadbooks (1965) and Guthrie (1973) provide zoological and paleontological evidence to suggest that *O. princeps collaris* originated in Beringia, whereas *O. princeps princeps* had a southern North American origin.

These subspecies are separated presently by about 500 miles (800 km) of country in which pikas are not found (Youngman 1975, p. 56).

Family Leporidae

Lepus americanus (snowshoe hare)

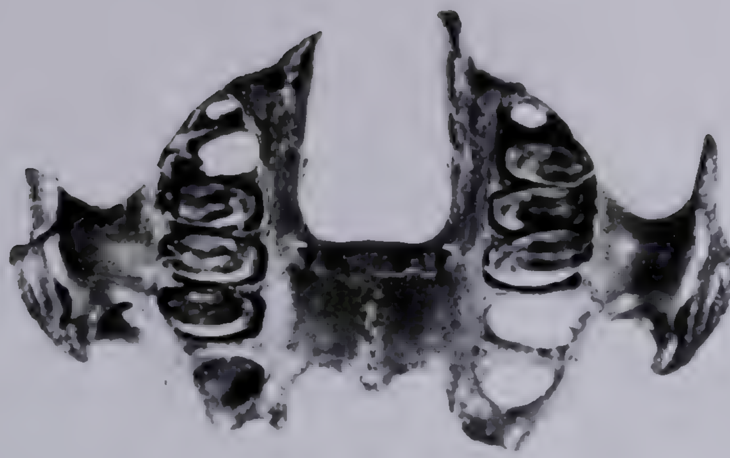
Snowshoe hare fossils (Figure 11A-C, Table 15) are relatively common in the Old Crow Pleistocene deposits compared to those of arctic hares *(Lepus arcticus)*. Also, they are generally better preserved. Only mandibles are described, except for a single maxillary fragment. Unless otherwise indicated, these specimens are stained brown. They closely match in size and shape a series of Recent *Lepus americanus* specimens from the Yukon Territory and Alaska.

Referred specimens

NMC 22324 from Old Crow Locality 27W is a maxillary fragment including: LP^3-LM^1 and the sockets for LP^2-LM^3; RP^4-RM^2 and the sockets for LP^2-LP^3; palatal region; anterior parts of the zygomatic arches.

NMC 28740 from Old Crow Locality 104 is a right mandible with the right incisor, RP_3-RM_2 and the alveolus for RM_3. The incisor is unusually light in color (ivory)

Figure 11. A. Maxillary fragment with LP^3-LM^1 and RP^4-RM^2 of a Pleistocene snowshoe hare *(Lepus americanus)* (NMC 22324, Old Crow Locality 27W). B. Lateral view of a left mandible with LP_3-LM_2 (NMC 19492, Old Crow Locality 65). C. Occlusal view of NMC 19492.

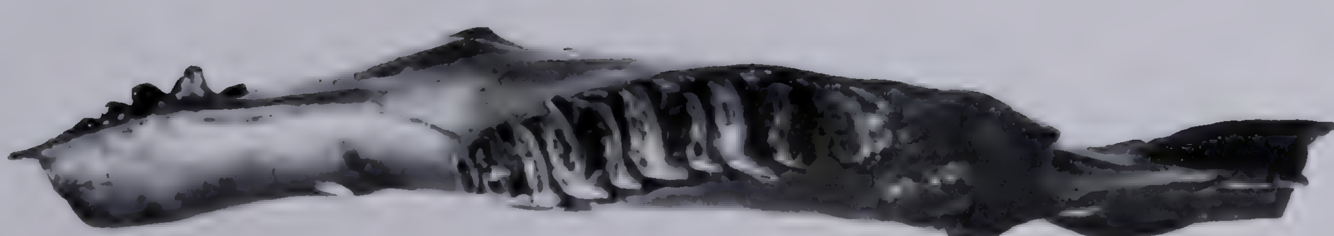


5 MM

A

B

5 MM



C

Table 15. Measurements of Pleistocene snowshoe hare (*Lepus americanus*) mandibles from the Yukon Territory compared to those of Recent North American snowshoe hares.

SPECIMENS		SEX	MEASUREMENTS (mm) *															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Lepus americanus, Pleistocene, Old Crow Area, Y.T.																		
NMC 28740	Loc. 104	-	-	7.1	15.6	17.6	13.2	16.5	3.4	2.9	2.9	3.3	3.3	3.5	3.2	3.3	-	-
NMC 28609	Loc. 65	-	57.4	8.0	16.0	18.4	13.6	16.1	-	-	3.2	3.5	2.9	3.4	3.1	3.2	-	-
NMC 26891	Loc. 22	-	-	7.7	15.1	17.3	13.8	15.9	3.2	2.6	3.1	3.1	2.8	3.0	2.6	2.8	-	-
NMC 19255	Loc. 65	-	-	7.3	15.7	16.9	12.9	15.5	3.2	2.9	2.9	3.4	3.0	3.2	2.9	3.2	-	-
NMC 25066	Loc. 20	-	-	7.3	16.1	16.5	12.6	16.4	3.2	2.8	2.8	3.4	3.1	3.2	3.0	3.1	-	-
NMC 19492	Loc. 65	-	-	7.1	16.4	17.4	13.3	15.2	3.5	2.9	2.8	3.6	2.9	3.4	3.0	3.4	-	-
NMC 19101	Loc. 28	-	-	7.6	15.5	16.7	12.1	15.0	3.1	2.7	2.9	3.3	2.9	3.3	3.0	3.1	-	-
NMC 19491	Loc. 65	-	-	8.0	15.1	17.4	13.8	15.4	2.6	2.7	3.1	3.2	2.8	3.2	2.9	3.0	-	-
NMC 26617	Loc. 65	-	-	7.3	15.6	17.7	12.6	15.7	-	-	2.8	2.9	2.7	2.9	2.9	2.9	-	-
NMC 19260	Loc. 65	-	-	-	-	-	13.1	14.8	-	-	2.8	3.1	3.1	3.1	2.9	2.9	-	-
NMC 15558	Loc. 20	-	-	7.1	16.0	16.7	13.1	14.8	-	-	-	3.2	2.9	3.0	3.0	3.1	-	-
NMC 18567	Loc. 27	-	-	8.5	-	17.7	13.2	-	3.2	2.9	2.7	3.5	3.1	3.4	-	-	-	-
NMC 19490	Loc. 65	-	-	7.5	16.0	16.6	12.4	15.2	-	-	2.9	3.4	2.9	3.3	2.9	3.2	-	-
NMC 18422	Loc. 29	-	-	8.1	16.0	-	12.3	15.6	-	-	3.1	3.4	2.8	3.3	2.8	3.0	-	-
NMC 13586	Loc. 11A	-	-	8.3	17.0	17.0	14.7	17.4	-	-	3.2	3.6	3.1	3.6	3.2	3.6	-	-
NMC 19257	Loc. 65	-	-	8.1	-	19.4	13.3	-	3.4	3.3	3.2	3.7	3.3	3.8	-	3.6	-	-
NMC 16901	Loc. 14N	-	-	9.1	-	18.0	-	-	3.6	2.7	3.1	3.5	2.9	3.4	2.9	3.1	-	-
NMC 24221	Loc. 22	-	-	-	-	-	13.5	15.7	-	-	2.7	3.4	2.9	3.2	3.0	3.1	-	-
NMC 24849	Loc. 11A	-	-	-	16.4	-	13.5	17.1	-	-	3.0	3.4	2.9	3.2	2.8	3.1	-	-
NMC 14801	Loc. 29	-	-	-	-	-	12.8	-	3.0	2.4	2.7	3.0	2.7	3.0	2.8	2.9	-	-
NMC 22254	Loc. 27W	-	-	-	-	-	10.8	-	-	-	2.7	3.1	2.9	3.0	3.4	2.9	-	-
NMC 19493	Loc. 65	-	-	8.4	-	17.3	-	-	3.1	2.6	2.7	3.2	-	-	-	-	-	-
NMC 27470	Loc. 127	-	-	9.1	-	18.4	-	-	3.5	3.2	3.1	3.6	-	-	-	-	-	-
NMC 19259	Loc. 65	-	-	8.2	-	18.8	-	-	2.9	3.3	3.0	3.5	-	-	-	-	-	-
Lepus americanus, Recent																		
NMC 20191	Y.T.	♀	55.5	7.1	14.1	17.1	11.9	13.3	3.0	2.7	2.7	3.1	2.6	3.1	2.5	2.9	2.0	1.9
NMC 31210	Y.T.	♂	52.1	6.6	14.4	15.8	12.0	13.3	3.1	2.7	2.8	3.1	2.8	2.9	2.7	2.8	1.3	2.2
NMC 33699	Y.T.	♀	57.4	7.9	16.0	17.0	13.5	14.8	3.3	2.6	2.7	3.4	2.8	3.3	2.7	3.2	2.2	1.9
NMC 2912	Y.T.	♂	53.6	6.6	15.0	16.2	12.1	14.3	3.2	2.8	2.8	3.1	3.0	3.0	2.8	3.1	2.0	1.9
NMC 40327	Alaska	♀	58.9	7.3	15.7	18.0	13.5	15.0	3.2	3.0	3.2	3.5	3.2	3.4	2.9	3.3	2.2	2.0
NMC 40324	Alaska	♂	55.4	7.5	15.7	17.0	12.1	14.1	3.2	2.8	2.8	3.2	2.8	3.1	3.1	3.0	2.2	1.8

* 1. Alveolar length P_2–M_3. 2. Length (anteroposterior diameter) P_3. 3. Width P_3. 4. Length P_4. 5. Width P_4. 6. Length M_1. 7. Width M_1. 8. Length M_2. 9. Width M_2. 10. Length M_3. 11. Width M_3.

compared to the rest of the mandible, which is deep, reddish-brown. NMC 28608 is a right mandible with RP_4-RM_2 and alveoli for the incisor, RP_2 and RM_2. The ascending ramus is complete, except for a perforation in the centre, which presumably resulted from erosion of thin bone in that region. The specimen was excavated from a sandy layer at Old Crow Locality 65. NMC 26891 from Old Crow Locality 22 is a right mandible with a heavily worn incisor, RP_4-RM_2 and the alveolus for RM_3. NMC 19258 is a right mandible with incisor and RP_3-RM_2. The incisor is an ivory color, generally lighter than the reddish brown mandibular bone. The specimen was excavated from Old Crow Locality 65. NMC 25064 from Old Crow Locality 20 is a right mandible with incisor, RP_3-RM_2, the alveolus for RM_3, and much of the ascending ramus. NMC 19492 from Old Crow Locality 65 is a left mandible with LP_3-LM_2 and sockets for the incisors and LM_3. The specimen is stained orange brown. NMC 19101 from Old Crow Locality 28 is a left mandible with LP_3-LM_2 and the socket for the incisor and LM_3. NMC 19491 from Old Crow Locality 65 is a left mandible with LP_3-LM_2 and the socket for the incisor and LM_3. Cheek teeth are reddish ivory in color and lighter than the brown bone of the mandible. NMC 28617 from Old Crow Locality 65 is a right mandible with RP_4-RM_2 and sockets for the incisor, RP_3 and RM_3. NMC 19260 from Old Crow Locality 65 is a left mandible with LP_4-LM_2.

The anterior part of the mandible is lacking. The specimen is stained reddish brown. NMC 15558 from Old Crow Locality 20 is a right mandible with RP_4-RM_2 and the alveoli for the incisor, RP_3 and RM_3. NMC 18367 from Old Crow Locality 27 is a left mandible with LP_3-LM_1. NMC 19490 from Old Crow Locality 65 is a right mandible with RP_4-RM_2 and alveoli for the incisor, LP_4 and LM_3. NMC 18422 from Old Crow Locality 29 is a right mandible with RP_4-RM_2 and alveoli for RP_3 and RM_3. NMC 13586 from Old Crow Locality 11A is a right mandible with RP_4-RM_2 and alveoli for the incisor, RP_3 and RM_3. It is stained a dark reddish brown. NMC 19257 from Old Crow Locality 65 is a right mandible with a heavily worn right incisor and RP_3-RM_2. The specimen is stained blackish brown. NMC 16901 from Old Crow Locality 14N is a right mandible with incisor, RP_3-RM_2 and the medial half of the alveolus for RM_3 (part of the lateral surface is stripped away exposing the cheek teeth). The specimen is stained reddish brown. NMC 24221 from Old Crow Locality 20 is the posterior part of a left mandible with LP_4-LM_2 and the alveolus for LM_3. NMC 24849 from Old Crow Locality 11A is the posterior part of a right mandible with RP_4-RM_2 and alveoli for RP_3 and RM_3. The specimen is stained orange brown, and evidently was derived from an oxidized sandy matrix. NMC 22254 from Old Crow Locality 27W

is a right mandible with unevenly worn cheek teeth (RP_4-RM_2), the alveolus and part of the root of RP_3, and part of the alveolus of RM_3. NMC 19493 from Old Crow Locality 65 is an anterior fragment of a right mandible with incisor and RP_3-RP_4. The teeth are lighter in color than the mandible. NMC 27470 from Old Crow Locality 127 is an anterior mandible fragment with the incisor and RP_3-RP_4. NMC 19259 from Old Crow Locality 65 is an anterior part of a left mandible with LP_3-LP_4 and a partial socket for the incisor. The specimen is stained blackish brown; the teeth are lighter.

Discussion

It is difficult to account for the fact that approximately 40% of the specimens described were derived from Old Crow Locality 65. The organic sandy gravel overlying the basal clay unit at this site may be part of a constructional terrace formed at the close of the Wisconsin glaciation, for at least one complete specimen of the freshwater mollusc *Anodonta beringiana* was found in the fossiliferous layer. This suggests that the organic sand cannot be correlated with Unit 2 at Old Crow Locality 44, but that it was deposited during the downcutting of the Old Crow River about 10,800 years ago, prior to a subsequent depositional phase in the area. Permineralization of the snowshoe hare mandibles resulting in their being stained brown indicates that they are of pre- late Wisconsin age.

The origins of *Lepus* are discussed in the section on the arctic hare *(Lepus arcticus)*. The snowshoe hare first appears during the Illinoian glaciation. It seems to be related to the Eurasian varying hare *(Lepus timidus)*, which is first well known in Eem (Sangamon) interglacial deposits of Europe (Kurtén 1968, p. 229). Although *Lepus* cf. *townsendi*, the white-tailed jackrabbit, has been reported from Sangamon and mid- Wisconsin age deposits at Medicine Hat, Alberta (Stalker and Churcher 1970), the snowshoe hare has not been definitely recorded before from Canadian Pleistocene deposits. However, it may occur in Champlain Sea age deposits at Montreal (Harington, 1972, p. 36).

The snowshoe hare is a medium-sized hare with large, broad hind feet. It is mainly confined to the northern forests of North America. Its northern limit in the Yukon Territory, Northwest Territories and Ungava is the tree line. The species presently occurs in the Old Crow Basin. It prefers forests, swamps and riverside thickets. During the summer snowshoe hares eat a wide variety of grasses and forbs, while in winter they live on buds, twigs, bark and evergreen leaves of woody plants. They are an important link in the food chains between plants and carnivorous animals. Major predators are owls, lynx, fox,

wolf and mink (Banfield 1974, pp. 80-84).

Lepus arcticus (arctic hare)

Arctic hare specimens (Figure 12A-C, Tables 16-17) are less commonly found in the Old Crow Pleistocene deposits than those of snowshoe hares *(Lepus americanus)*. Two maxillary fragments and 11 mandibular fragments are described here. The fine sculptural details preserved on the cranial bone of a Recent specimen of *Lepus arcticus* from the Northwest Territories (NMC 37775) are well matched in the Old Crow specimens. Also, the much larger size of arctic hares compared to snowshoe hares *(Lepus americanus)* allow the two species to be readily distinguished. All specimens are stained brown, unless otherwise indicated.

Referred specimens

NMC 24665 from Old Crow Locality 22 is a right maxillary fragment containing RP^3-RM^3, the alveolus for RP^2, and part of the right cheek area including the maxillary bone surrounding the teeth and the anterior part of the zygomatic arch. NMC 15584 from Old Crow Locality 28 is a right maxillary fragment with RM^1-RM^2 and the alveolus for RM^3.

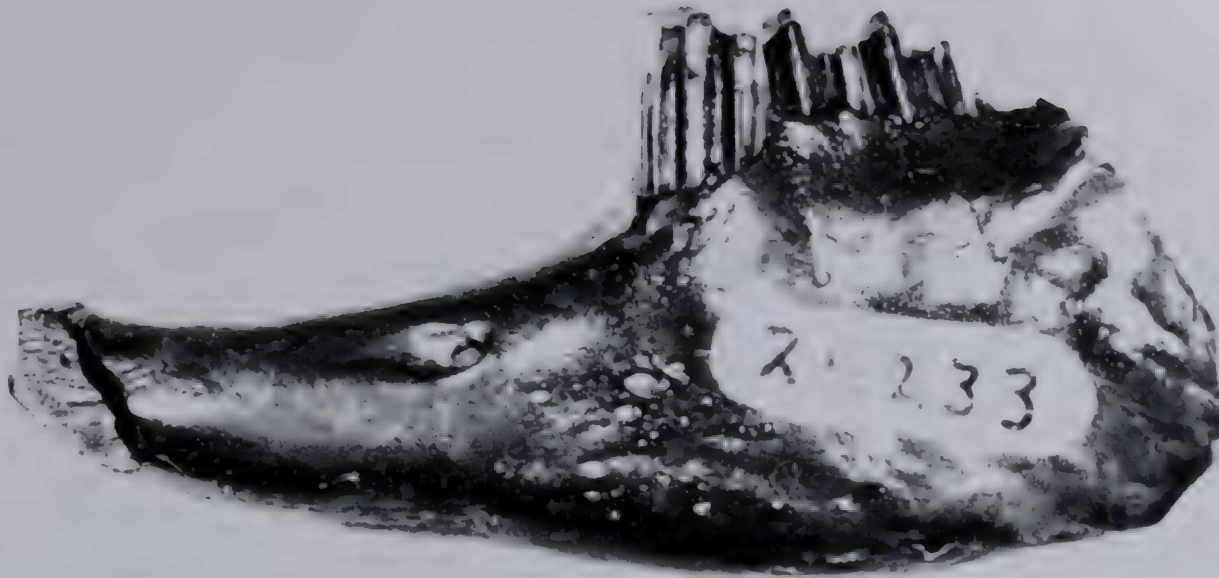
NMC 28653 is a left mandible with LP_3-LM_3 and the

Figure 12. Left mandibular fragment with LP_3-LM_1 of a Pleistocene arctic hare *(Lepus arcticus)* (NMC 24233, Old Crow Locality 22).

A. Lateral view.

B. Occlusal view. Left mandibular fragment with LP_3-LM_1 of a Pleistocene arctic hare *(Lepus arcticus)* (NMC 24647, Old Crow Locality 67).

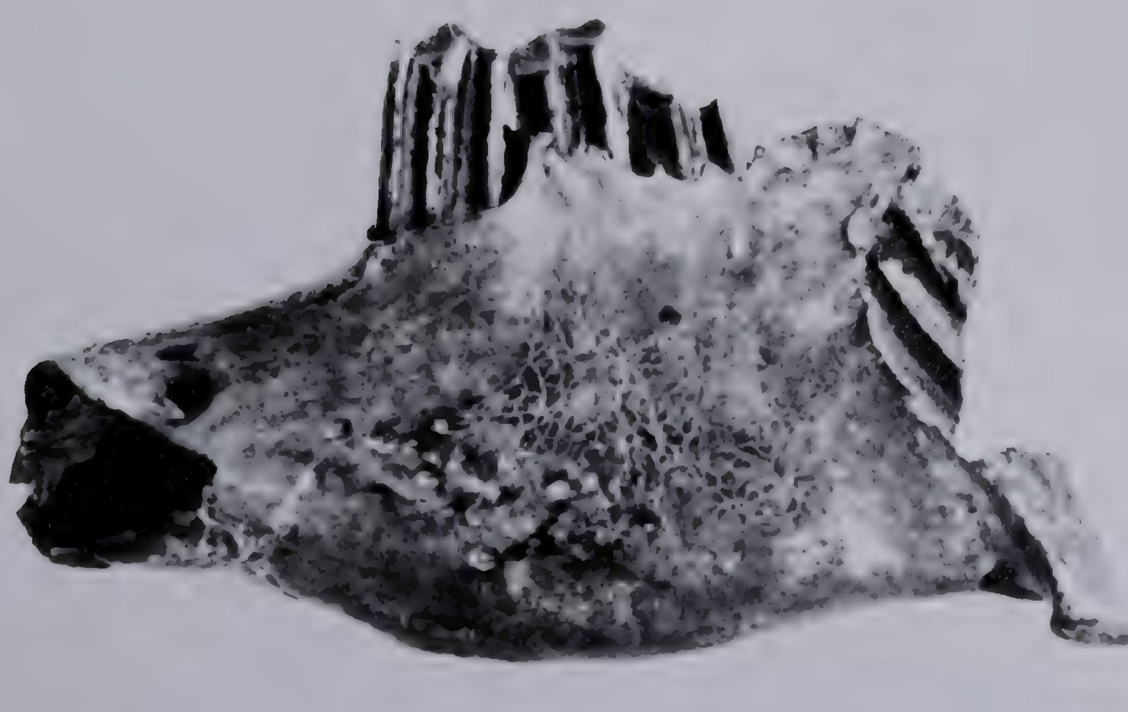
C. Lateral view.



A

5 MM

B



5 MM

C

Table 16. Measurements of Pleistocene arctic hare (*Lepus arcticus*) maxillae from the Yukon Territory compared to those of Recent arctic hares from the Northwest Territories.

SPECIMENS	SEX	MEASUREMENTS (mm) *										
		1	2	3	4	5	6	7	8	9	10	11
Lepus arcticus, Pleistocene, Old Crow Area, Y.T.												
NMC 24665 Loc. 22	-	19.9	3.1	6.0	3.1	6.0	3.1	5.7	2.7	4.8	1.2	1.9
NMC 15584 Loc. 28	-	-	-	-	-	-	3.1	5.4	2.9	4.7	-	-
Lepus arcticus, Recent, N.W.T.												
NMC 2870	♂	17.4	2.2	5.6	3.0	5.6	3.1	5.4	2.6	4.8	1.0	2.2
NMC 2864	♂	18.4	2.1	6.0	3.1	6.1	2.9	5.8	2.6	4.9	1.3	2.2
NMC 2672	♂	17.4	2.6	5.6	2.6	5.6	2.8	5.3	2.4	4.4	1.3	1.8
NMC 2859	♂	18.5	2.8	5.9	2.9	5.9	3.1	5.3	2.6	4.6	1.4	2.1
NMC 2662	♀	16.6	2.6	5.5	2.6	5.4	2.7	5.2	2.3	4.4	1.2	2.3
NMC 2863	♂	18.4	3.0	5.9	3.1	6.1	3.2	6.1	2.9	5.6	1.3	2.6

* 1. Alveolar length P^2–M^3.
2. Length (anteroposterior diameter) P^3.
3. Width P^3.
4. Length P^4.
5. Width P^4.
6. Length M^1.
7. Width M^1.
8. Length M^2.
9. Width M^2.
10. Length M^3.
11. Width M^3.

Table 17. Measurements of Pleistocene arctic hare (*Lepus arcticus*) mandibles from the Yukon Territory compared to those of Recent arctic hares from the Northwest Territories.

SPECIMENS	SEX	MEASUREMENTS (mm) *															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Lepus arcticus. Pleistocene, Old Crow Area, Y.T.																	
NMC 28653 Loc. 136	-	-	8.6	20.0	24.2	17.9	19.0	4.2	3.4	3.2	3.8	3.7	4.0	3.7	3.9	2.7	2.3
NMC 24647 Loc. 67	-	-	8.8	-	-	16.8	-	4.3	3.3	4.1	3.7	3.9	4.3	-	-	-	-
NMC 24233 Loc. 22	-	-	8.9	-	23.7	17.9	-	4.6	3.8	4.3	4.4	3.8	4.4	-	-	-	-
NMC 27305 Loc. 29	-	-	-	-	20.9+	17.1	-	4.3	3.6	3.6	3.8	3.5	4.1	-	-	-	-
NMC 26745 Loc. 19	-	-	-	-	-	-	19.9	-	-	3.6	4.1	3.7	4.1	3.9	4.1	-	-
NMC 25310 Loc. 27W	-	-	-	-	-	18.2	-	-	-	3.7	4.2	4.0	4.2	4.0	4.2	-	-
NMC 28682 Loc. 27	-	-	8.8	-	22.7	-	-	4.3	3.5	3.8	4.0	-	-	-	-	-	-
NMC 15583 Loc. 28	-	-	9.0	-	23.3	-	-	4.0+	3.5	3.9	4.2	-	-	-	-	-	-
NMC 25208 Loc. 20	-	-	-	-	-	18.6	-	-	-	-	-	4.1	4.8	4.1	4.6	-	-
NMC 22252 Loc. 27W	-	-	8.4	-	21.2	-	-	-	-	-	-	-	-	-	-	-	-
Lepus arcticus. Recent, N.W.T.																	
NMC 2870	♂	70.2	8.2	18.4	23.8	15.9	17.4	3.9	3.4	3.4	3.9	3.8	4.0	3.4	4.1	2.5	2.3
NMC 2864	♂	66.5	8.1	19.0	21.2	15.2	16.8	4.1	3.5	4.6	4.0	3.6	4.1	3.3	3.9	2.6	2.3
NMC 2872	♂	72.7	8.9	18.6	25.5	16.8	18.4	4.1	3.4	3.4	3.7	3.5	4.0	3.4	3.7	2.6	2.4
NMC 2859	♂	74.6	9.0	20.2	24.0	16.8	18.4	4.0	3.5	3.7	4.0	3.6	3.9	3.6	3.8	2.7	2.4
NMC 2862	♀	68.6	8.2	17.5	21.5	16.3	16.8	3.9	3.2	3.3	3.6	3.2	3.6	3.2	3.7	2.2	2.3
NMC 2863	♂	70.2	8.4	19.9	22.5	16.5	17.7	4.2	3.6	3.4	4.2	3.3	4.1	3.5	4.1	2.4	2.3

* 1. Mandible length (superior alveolar margin of I_1 to posterior of angle). 2. Diastema depth. 3. Alveolar length (P_3-M_3) 4. Diastema length (superior alveolar margin of I_1 to anterior alveolar margin of P_3). 5. Mandible depth (M_1). 6. Mandible depth (posterior of M_3). 7. Length P_3. 8. Width P_3. 9. Length P_4. 10. Width P_4. 11. Length M_1. 12. Width M_1. 13. Length M_2. 14. Width M_2. 15. Length M_3. 16. Width M_3.

complete diastema including the incisor socket. The ascending ramus is lacking. The specimen is from Old Crow Locality 136 and is stained blackish brown. NMC 24233 from Old Crow Locality 22 is the anterior part of a left mandible with LP_3-LM_1. NMC 24647 from Old Crow Locality 67 is the central part of a left mandible with LP_3-LM_1. Fragments of the incisor and LM_2 are lodged in their alveoli. NMC 27305 is an anterior fragment of a right mandible with RP_3-RM_1 and much of the diastema including a broken incisor. It was excavated at Old Crow Locality 29. NMC 26745 from Old Crow Locality 19 is a right mandible with RP_4-RM_2 and parts of the alveoli for RP_3 and RM_3. NMC 25310 from Old Crow Locality 27W is a left mandible with LP_4-LM_2. The jaw is stained blackish brown, and rust colored matrix adheres to the interior part of the angle. NMC 28682 from bar deposits at Old Crow Locality 27 is the anterior part of a right mandible with the complete incisor, diastema, RP_3-RP_4 and the alveolus for the anterior loop of RM_1. Compared to a Recent female arctic hare specimen from Banks Island, N.W.T. (NMC 37775), the incisor of the fossil is broad and well-worn. NMC 15583 from Old Crow Locality 28 is the anterior part of a right mandible with RP_3-RP_4. It includes the complete diastema and a right incisor which has broken off near the alveolar margin. NMC 25208 from Old Crow Locality 20 is the central part of a left mandible with

LM_1-LM_2, the complete alveolus for LP_4 and partial alveoli for LP_3 and LM_3. The teeth are relatively large. NMC 22252 from Old Crow Locality 27W is the anterior part of a left mandible including the anterior margin of the alveolus for LP_3, the diastema and a well worn incisor. NMC 24737 from Old Crow Locality 11A is an anterior fragment of a left mandible lacking teeth. Alveoli for the incisor and LP_3-LM_1 are present. The specimen is stained blackish brown. It is not complete enough to provide useful measurements.

Discussion

Evidently these are the first specimens of arctic hare from Canadian and perhaps North American Pleistocene deposits. Generally, they fall within the same size range as a series of Recent specimens from the Northwest Territories. Postcranial specimens that I have identified as *Lepus arcticus* have been excavated from the fossiliferous layer at Old Crow Locality 44, and therefore are possibly of Sangamon age. Another postcranial bone was collected from a patch of fine gravel approximately 30 feet (9.1 m) above the level of the Old Crow River at that locality, which may be of late Sangamon or early Wisconsin age.

The origins of *Lepus* are still rather obscure. The transition from such lagomorphs as *Alilepus*, *Pratilepus*

and *Serengetilagus* seems to have occurred about late Pliocene time throughout the Holarctic. Probably an important factor in the extinction of *Hypolagus* was the flourishing populations of *Lepus* and *Sylvilagus* in the New World and *Lepus*, *Oryctolagus* and *Caprolagus* in the Old World during the early Pleistocene (Dawson 1967, p. 303). Among the earliest records of *Lepus* in North America are: *Lepus* sp. in the San Pedro Valley, California paleomagnetically dated at 1.9 million years, *Lepus* cf. *californicus* from the Borchers fauna (Aftonian) of Kansas, and *Lepus* sp. of the Vallecito Creek fauna (Johnson *et al.* 1975, p. 10). Ancestors of *Lepus arcticus* are not known. I suggest this species may have evolved from a smaller boreal varying hare with affinities to Eurasian *Lepus timidus* or the related snowshoe hare (*Lepus americanus*) in the middle Pleistocene of Beringia.

The arctic hare is a large, heavy-bodied hare of the arctic tundra of Canada and Greenland. In winter it is pure white with black-tipped ears. In summer it is grayish, particularly in the more southerly parts of its range. Females average slightly larger than males. A closely related species, *L. othus*, occupies northwest Alaska. The arctic hare no longer occurs in the Yukon Territory, but is found as close as the mouth of the Mackenzie Delta. In summer, arctic hares feed mainly on grasses, sedges,

saxifrages, campions, mountain sorrel and the twigs and roots of arctic willow and crowberry. In winter they feed along wind-cleared slopes. Sometimes they break snowcrusts with their forepaws to reach grasses, sedges and willows. They are an important prey species for the arctic fox and wolf. Snowy Owls and Rough-legged Hawks also feed on them (Banfield 1974, pp. 85-87).

Order Rodentia

Family Scuiridae

Marmota cf. *monax* (woodchuck)

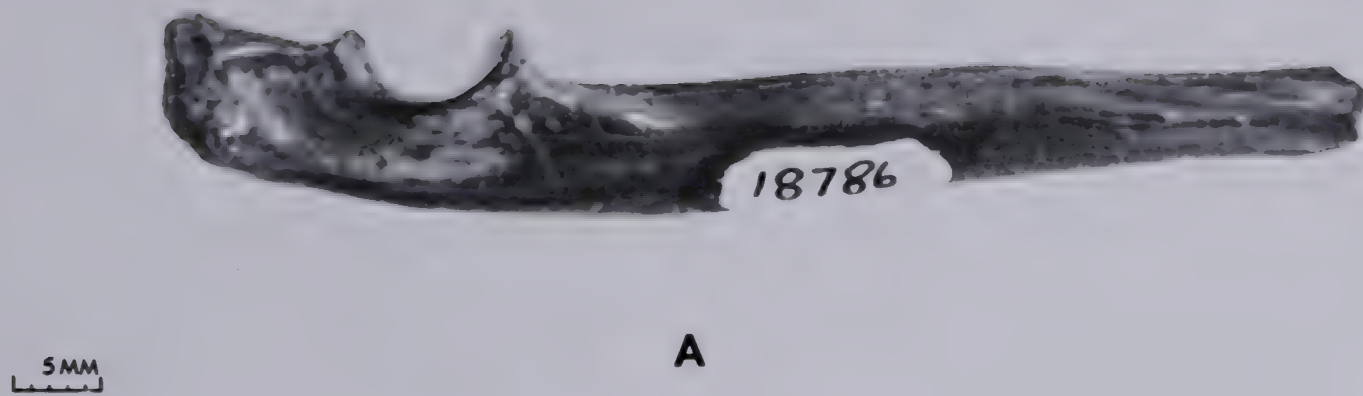
Referred specimen

A single specimen consisting of a left ulna lacking the distal end (NMC 18786; Figure 13A-C) was collected at Locality 20 on the Old Crow River. It is stained dark brown and was derived from oxidized sediment according to matrix adhering to the medial surface of the bone posterior to the semilunar notch. A well developed ridge is evident on the mediodistal part of the shaft of NMC 18786, which is seen also in a Recent specimen of *M. monax* to which it was compared. This ridge was not present on Recent specimens of the hoary marmot (*M. caligata*) that I examined, but this possibly diagnostic postcranial character should be checked in a larger series of Recent *Marmota* specimens.

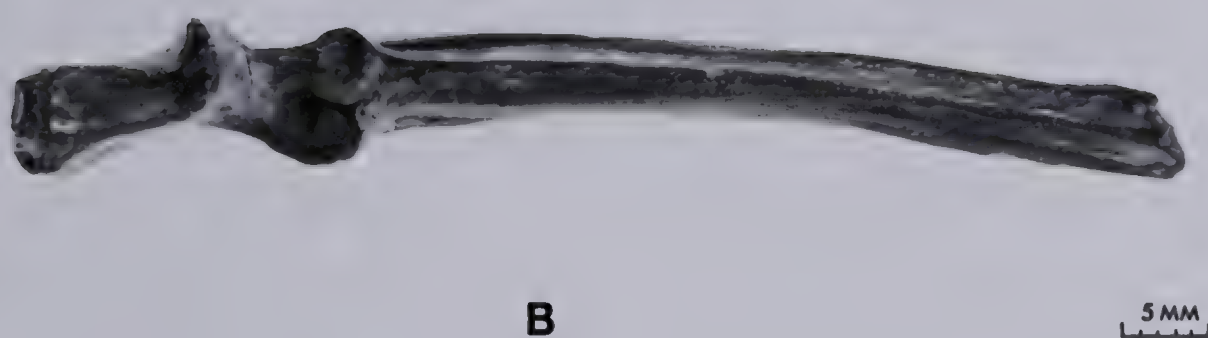
Figure 13. Left ulna, lacking the distal end, of a Pleistocene woodchuck *(Marmota* cf. *monax)* (NMC 18786, Old Crow Locality 20).

A. Medial view. B. Anterior view.

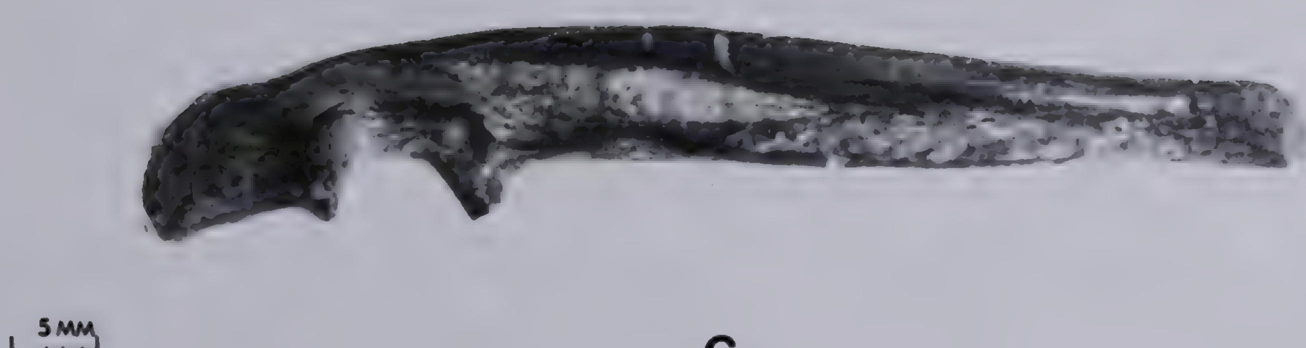
C. Lateral view.



A



B



C

The fossil is almost a perfect match for the same element of a Recent male woodchuck (*M. monax monax*; NMC 31943) from Pennsylvania. It is markedly smaller than two Recent female hoary marmot (*M. caligata caligata*) ulnae from Keno Hill, Yukon Territory (NMC 31241, 35342). The fossil probably represents the woodchuck, which presently has a spotty distribution in the southern half of the Yukon (Youngman 1975, p. 64).

Discussion

Because the Yukon fossil is so deeply stained, I suggest it is of pre-late Wisconsin age. Apart from it, the only published report of the woodchuck from Canadian Pleistocene deposits concerns a specimen from the Don Formation of Sangamon interglacial age in Toronto. In the United States, the woodchuck has been recorded from such Wisconsin sites as Cherokee Cave, Missouri (Hibbard 1958, p. 13) and Robinson Cave, Tennessee (Guilday *et al.* 1969, p. 49).

Marmots (*Marmota*) probably originated in the Nearctic during the Tertiary. Fossils differing only slightly from extant specimens have been found in middle Pliocene (Hemphillian) deposits in Nevada. The genus reached Asia in the late Pliocene (Csarnotan), but did not reach Europe until the mid- Pleistocene (Repenning 1967,

p. 298). The fossil marmots from China are referred to *M. bobak* (Kurtén 1968, p. 194). Rausch (1953) regards the alpine marmot *(M. marmota)* of Europe as conspecific with the hoary marmot *(M. caligata)*, which lives in mountainous areas of northwestern North America. The alpine marmot appeared in Europe as early as the Riss (Illinoian), but did not become widespread there until the Würm (Wisconsin) glaciation. The earliest record of woodchuck or marmot *(Marmota* sp.*)* from Eastern Beringia is based on teeth and fragmentary postcranial elements from the Cape Deceit Formation (?Nebraskan) of Alaska (Guthrie and Matthews 1971, p. 492).

Woodchucks are robust marmots which may reach 2 feet (0.6 m) in length and 14 pounds (6.4 kg) in weight. They hibernate in underground dens during the winter. Woodchucks are well adapted to living in forested regions where grassy clearings are available. They flourish in areas cultivated by people. Their diet consists mainly of green vegetation. At present, the red fox *(Vulpes vulpes)* is the woodchuck's greatest predator. During the late Pleistocene, probably wolves and some of the larger cats were more important as predators of these animals.

Spermophilus parryi (arctic ground squirrel)

Ground squirrel remains (Figure 14A-B, Tables 18-19) are among the most common rodent fossils from the Pleistocene deposits of the Yukon. Although many post-cranial specimens have been collected from the Old Crow Basin, only some of the more complete maxillary and mandibular fragments are described. Unless otherwise noted the Old Crow specimens are stained dark brown. Occasionally, during monitoring of the muck faces at the placer operations near Dawson, parts of ground squirrel nests buried deeply in the permafrost are exposed. In the autumn of 1967, Harold Schmidt collected a complete nest with nesting grass, fecal pellets, surrounding matrix and parts of the skeleton of a relatively small individual (NMC 21094). A more detailed co-operative study of this material is planned, especially with regard to the paleoecological implications of the evidence. Only measurements on a maxilla and mandible from this skeleton are given here.

<u>Referred specimens</u>

In 1974 I collected two fairly complete ground squirrel crania at T. Kosuta's placer operation where 80 Pup enters Hunker Creek near Dawson (Dawson Locality 10). NMC 25999 is the larger of the two, having both upper incisors and LM^2-LM^3, in addition to alveoli for the

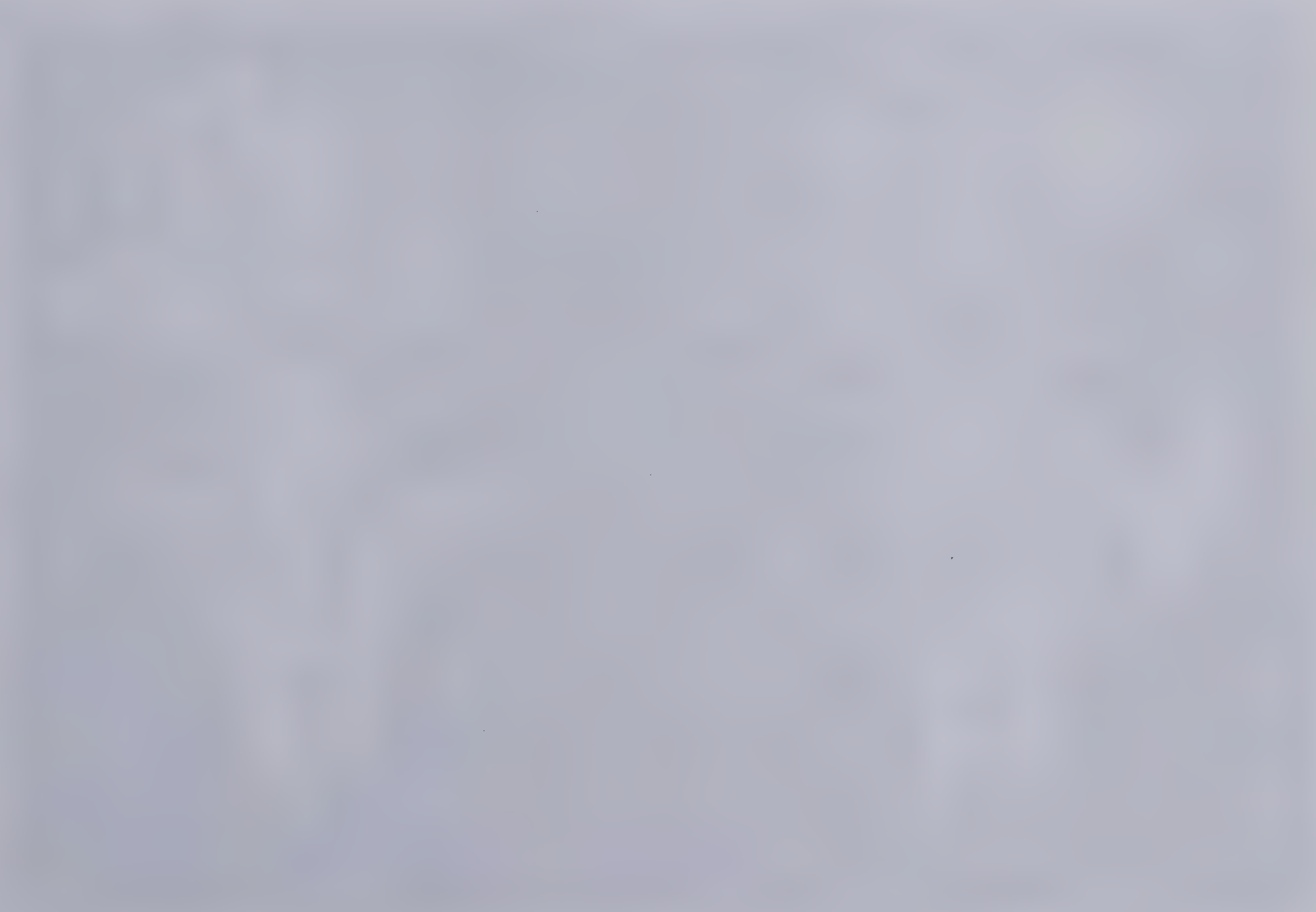
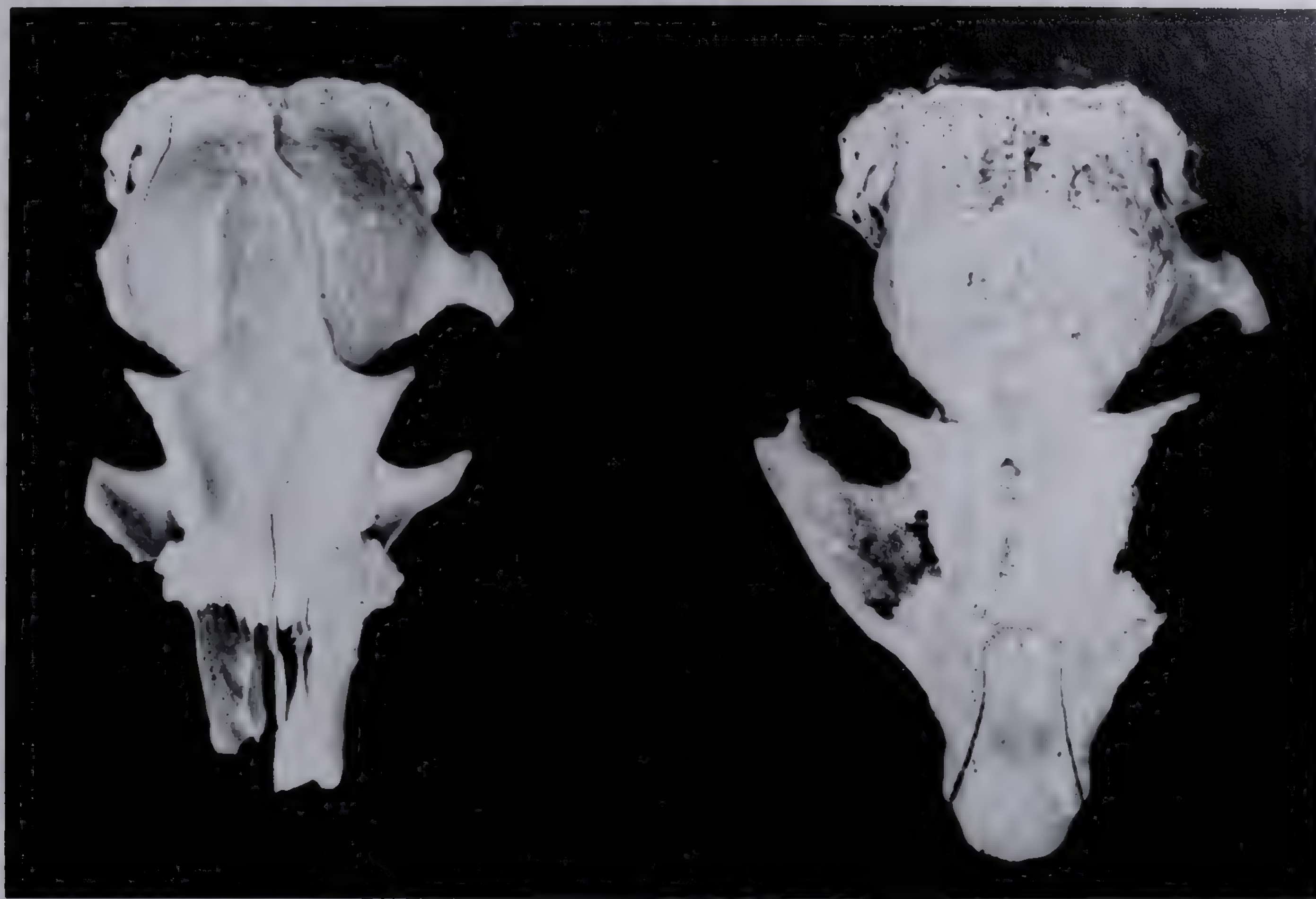


Figure 14. Fragmentary crania of Pleistocene arctic ground squirrels *(Spermophilus parryi)* from Dawson Locality 10. A. Dorsal views of NMC 25998 (left) and NMC 25999 (right). B. Ventral views of NMC 25998 (left) and NMC 25999 (right).



3 CM

A

B

3 CM

Table 18. Measurements of Pleistocene arctic ground squirrel (*Spermophilus parryi*) crania from the Yukon Territory compared to those of Recent arctic ground squirrels from the Yukon.

SPECIMENS	SEX	MEASUREMENTS (mm) *														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Spermophilus parryi. Pleistocene, Yukon Territory																
NMC 25939 Dawson Loc. 10	-	60.5	33.0	12.7	12.2	21.8	13.9	4.7	-	-	-	-	3.0	3.7	3.7	3.6
NMC 25998 Dawson Loc. 10	-	-	31.9	12.7	13.5	-	14.0	3.8	-	-	-	-	-	-	3.8	3.5
NMC 21094 Dawson Loc. 28	-	-	-	-	-	-	12.4	3.8	2.5	3.2	2.8	3.4	2.6	3.4	3.7	3.2
NMC 19108 Old Crow Loc. 28	-	-	-	-	-	-	15.5e	5.0	-	-	-	-	-	-	-	-
NMC 18225 Old Crow Loc. 11A	-	-	-	-	-	-	13.9	4.4	-	-	-	-	-	-	-	-
NMC 20018 Old Crow Loc. 65	-	-	-	-	-	-	-	4.7	-	-	-	-	-	-	-	-
Spermophilus parryi. Recent, Y.T.																
NMC 33742	♀	-	-	-	-	-	13.4	4.0	2.4	3.2	2.4	3.7	2.9	3.5	3.7	3.6
NMC 33732	♂	-	-	-	-	-	13.1	3.9	2.8	3.1	2.9	3.5	3.0	3.6	3.7	3.5
NMC 29379	♂	-	-	-	-	-	13.2	3.8	2.8	2.9	2.7	3.3	3.0	3.5	3.8	3.4
NMC 29878	♀	-	-	-	-	-	12.5	3.9	2.5	3.1	2.7	3.3	2.6	3.6	3.7	3.4
NMC 33741	♂	-	-	-	-	-	13.8	4.3	3.1	3.5	3.1	3.8	3.3	4.0	4.1	3.7
NMC 30326	♂	-	-	-	-	-	12.9	3.9	2.6	3.1	2.9	3.9	3.2	3.6	3.8	3.6
NMC 33739	♀	-	-	-	-	-	12.8	3.7	2.4	2.5	2.7	3.3	2.9	3.5	3.5	3.2
NMC 33734	♀	-	-	-	-	-	12.8	3.9	2.4	2.6	2.9	3.4	3.1	3.6	3.7	3.4
NMC 33737	♀	-	-	-	-	-	13.8	4.0	2.7	3.2	2.9	3.6	3.1	3.8	3.9	3.5
NMC 33738	♀	-	-	-	-	-	13.2	3.9	2.3	2.5	2.9	3.4	3.2	3.5	3.7	3.5
NMC 33733	♂	-	-	-	-	-	13.2	4.0	2.4	2.6	2.9	3.4	2.9	3.7	3.6	3.5
NMC 30320	♂	-	-	-	-	-	13.2	3.6	2.4	2.8	3.4	3.0	3.5	3.5	3.9	3.6
Spermophilus parryi parryi. Recent, Y.T.																
(Youngman 1975, p. 68)	♂♂															
M		60.0	30.0	12.8	13.2	21.9	13.3	-	-	-	-	-	-	-	-	-
OR		58.4–	28.6–	11.6–	12.3–	21.0–	11.1–	-	-	-	-	-	-	-	-	-
		62.2	30.5	13.6	14.2	23.2	13.9	-	-	-	-	-	-	-	-	-
N		10	10	10	10	10	10	-	-	-	-	-	-	-	-	-
SD		1.23	0.69	0.56	0.67	0.63	0.54	-	-	-	-	-	-	-	-	-
SE		0.39	0.23	0.19	0.21	0.20	0.17	-	-	-	-	-	-	-	-	-
M	♀♀	57.1	28.7	12.1	13.5	20.8	13.1	-	-	-	-	-	-	-	-	-
OR		56.4–	27.6–	11.2–	13.0–	20.2–	12.5–	-	-	-	-	-	-	-	-	-
		59.2	30.3	13.3	14.9	21.7	13.4	-	-	-	-	-	-	-	-	-
N		12	12	12	12	12	12	-	-	-	-	-	-	-	-	-
SD		0.83	0.80	0.64	0.50	0.54	0.38	-	-	-	-	-	-	-	-	-
SE		0.24	0.23	0.19	0.14	0.16	0.11	-	-	-	-	-	-	-	-	-

* 1. Greatest length of cranium. 2. Palatal length. 3. Least interorbital width. 4. Width at postorbital constriction. 5. Nasal length. 6. P^3–M^3 alveolar length. 7. Maximum width across alveoli. 8. Length P^4. 9. Width P^4. 10. Length M^1. 11. Width M^1. 12. Length M^2. 13. Width M^2. 14. Length M^3. 15. Width M^3.

Table 19. Measurements of Pleistocene arctic ground squirrel (*Spermophilus parryi*) mandibles from the Yukon Territory compared to those of Recent arctic ground squirrels.

SPECIMENS	SEX	MEASUREMENTS (mm) *												
		1	2	3	4	5	6	7	8	9	10	11	12	13
Spermophilus parryi. Pleistocene, Yukon Territory.														
NMC 21094 Dawson Loc. 28	–	–	4.4	11.4	8.3	7.3	2.5	2.7	2.4	3.0	2.6	3.0	3.5	3.1
NMC 18803 Old Crow Loc. 20	–	–	6.1	13.6	10.8	9.4	2.8	3.2	2.9	3.3	3.1	3.5	4.2	3.6
NMC 15577 Old Crow Loc. 28	–	–	6.6	14.1	12.1	10.1	3.0	3.2	3.1	3.3	3.1	3.8	5.0	3.6
NMC 18624 Old Crow Loc. 27	–	–	5.8	12.2	10.0	9.1	3.0	3.1	2.7	3.0	2.8	3.2	4.0	3.5
NMC 27825 Old Crow Loc. 67	–	–	6.1	13.1	11.0	9.2	2.8	3.3	3.0	3.3	3.0	3.6	–	–
NMC 27826 Old Crow Loc. 67	–	–	6.0	14.2	10.0	9.6	–	–	3.0	3.2	3.1	3.5	4.3	3.8
NMC 15837 Old Crow Loc. 44	–	–	6.7	14.5	12.5	9.9	3.0	3.4	3.2	3.9	3.5	3.8	–	–
NMC 24362 Old Crow Loc. 11A	–	–	5.8	14.0	9.6	8.6	–	–	2.9	3.3	2.9	3.6	4.4	3.5
NMC 15712 Old Crow Loc. 28	–	–	–	15.0	–	9.7	3.4	3.7	3.0	3.8	3.4	4.0	–	–
NMC 22253 Old Crow Loc. 27W	–	–	5.7	14.2	–	8.5	3.0	3.2	3.5	3.4	3.2	3.3	–	–
NMC 15250 Old Crow Loc. 22	–	–	–	–	–	–	2.6	3.3	2.9	3.3	3.3	3.6	–	–
NMC 15578 Old Crow Loc. 28	–	–	7.1	14.0	11.4	10.7	–	–	–	–	3.5	3.8	4.5	4.0
NMC 25307 Old Crow Loc. 27W	–	–	–	–	–	7.7	–	–	2.8	2.9	3.0	3.0	–	–
NMC 15838 Old Crow Loc. 44	–	–	–	–	–	–	–	–	–	–	3.0	3.1	3.6	3.0
NMC 24875 Old Crow Loc. 11A	–	–	–	–	–	8.3	2.5	2.6	–	–	–	–	–	–
NMC 24358 Old Crow Loc. 11A	–	–	5.8	13.7	–	8.1	–	–	–	–	–	–	–	–
NMC 15816 Old Crow Loc. 44	–	–	–	14.9	–	9.0	–	–	–	–	–	–	–	–
NMC 24988 Old Crow Loc. 11A	–	41.8	6.0	15.0	10.9	9.5	–	–	–	–	–	–	–	–
NMC 22057 Old Crow Loc. 27W	–	–	–	15.0	–	9.3	–	–	–	–	–	–	–	–
NMC 26794 Old Crow Loc. 20	–	–	6.3	15.0	10.4	9.4	–	–	–	–	–	–	–	–
NMC 22250 Old Crow Loc. 27W	–	–	6.1	14.4	10.4	8.8	–	–	–	–	–	–	–	–
NMC 24994 Old Crow Loc. 11A	–	–	–	14.9	–	9.2	–	–	–	–	–	–	–	–
NMC 18625 Old Crow Loc. 27	–	–	–	13.3	–	–	–	–	–	–	–	–	–	–
Spermophilus parryi. Recent, Yukon Territory.														
NMC Uncataloged	♂	39.4	6.1	12.0	10.5	9.0	2.5	3.0	2.5	3.2	2.8	3.6	4.0	3.6
NMC 33742	♀	35.9	5.2	12.0	10.1	8.8	2.9	2.9	2.6	3.1	3.1	3.2	4.0	3.4
NMC 33732	♂	37.1	5.6	12.0	11.2	9.2	3.0	2.9	2.6	3.1	2.9	3.4	3.8	3.4
NMC 29879	♂	35.7	5.3	11.7	9.9	7.6	2.9	2.5	2.6	3.1	3.1	3.2	3.7	3.2
NMC 29878	♀	36.5	5.3	11.2	10.4	8.2	2.6	2.7	2.5	2.8	2.8	3.1	3.8	3.3
NMC 33741	♂	39.0	6.0	12.7	11.5	9.4	2.8	2.9	2.6	3.4	2.8	3.6	3.9	3.6
NMC 30326	♂	36.9	5.3	12.4	11.1	8.7	2.9	2.8	2.7	3.1	2.9	3.1	3.6	3.2
NMC 33739	♀	35.2	4.9	12.4	10.6	7.4	2.5	2.1	2.9	2.9	2.8	3.1	3.3	3.4
NMC 33734	♀	35.5	4.7	12.4	10.2	7.5	2.5	2.7	2.8	2.9	3.4	3.1	3.6	3.3
NMC 33737	♀	36.0	5.2	12.9	9.8	8.0	2.9	2.9	2.9	2.8	3.2	3.1	3.9	3.4
NMC 33738	♀	35.3	4.9	11.8	10.4	7.6	–	–	2.7	2.9	3.0	3.1	3.6	3.3
NMC 33733	♂	35.4	4.9	12.5	10.5	7.9	2.5	2.2	2.9	2.9	3.1	3.2	3.8	3.4

* 1. Mandible length (superior alveolar margin of I_1 to posterior of angle). 2. Diastema depth. 3. Alveolar length (P_4-M_3). 4. Diastema length (superior alveolar margin of I_1 to anterior alveolar margin of P_4). 5. Mandible depth (M_2). 6. Length P_4. 7. Width P_4. 8. Length M_1. 9. Width M_1. 10. Length M_2. 11. Width M_2. 12. Length M_3. 13. Width M_3.

remaining teeth. The anterior portion of the right zygomatic arch is present, the left one is lacking. NMC 25998 is a cranium with the left upper incisor, RM^3, and the alveoli for the remaining cheek teeth. The nasals are missing and the otic capsules and zygomatic arches are damaged. Both specimens are light brown.

The alveolar length and palatal length of these crania, of probable late Wisconsin age, are at the upper limit or are slightly greater than the maxima noted by Youngman (1975, p. 68) in Recent samples of male and female ground squirrels from the northwestern Yukon Territory.

NMC 21094 is a left maxilla with LP^4-LM^3 and the alveolus for LP^3. It is stained reddish brown and was collected *in situ* in a ground squirrel nest near the base of the muck and just above the surface of the gold-bearing gravel at Dawson Locality 28. NMC 19108 from Locality Old Crow 28 is a left maxilla with alveoli for LP^3-LM^2 and part of LM^3. It is connected to the anterior part of the zygomatic arch. NMC 18225 from Old Crow Locality 11A is a right maxilla with alveoli for LP^3-LM^3. NMC 20018 from Old Crow Locality 65 is a left mandible with alveoli for LP^3-LM^2.

NMC 21094 from Dawson Locality 28 is a right mandible with all teeth. Only the angle of the jaw and the coronoid process are lacking. Like the maxillary fragment from the same specimen mentioned previously, it is stained reddish brown. NMC 18803 from Old Crow Locality 20 has all the cheek teeth, but the distal end of the incisor is missing. NMC 15577 from Old Crow Locality 28 is a right mandible with all cheek teeth and the partial alveolus for the incisor. NMC 18624 from Old Crow Locality 27 is a right mandible with complete cheek teeth. It lacks the distal end of the incisor. NMC 27825 from Old Crow Locality 67 is a left mandible with incisor, LP_1-LM_2 and the alveolus for LM_3. NMC 27826 from Old Crow Locality 67 is a left mandible with the incisor, LM_1-LM_3 and the alveolus for LP_4. NMC 15837 is a left mandible with LP_4-LM_2 and the alveoli for the incisor and LM_3. It was excavated from the fossiliferous layer at Old Crow Locality 44, and is, therefore, more than 54,000 years old. NMC 24362 from Old Crow Locality 11A is a right mandible with RM_1-RM_3 and alveoli for the incisor and RP_4. A perforation approximately 3 mm in diameter on the lateral surface of the mandible posterior to RM_3 may be the mark of a carnivore canine. NMC 15712 from Old Crow Locality 27W is a left mandible with LP_4-LM_2, broken incisor and alveolus for LM_3. NMC 15250 from Old Crow Locality 22 is a small right mandible

fragment with RP_4-RM_2. Because the teeth are heavily worn, presumably an old individual is represented. NMC 15578 from Old Crow Locality 28 is a relatively large right mandible with RM_2-RM_3 and the roots of RP_4 and RM_1. The distal end of the incisor is missing. NMC 25307 from Old Crow Locality 27W is an anterior fragment of a left mandible with LM_1-LM_2, the alveolus for LP_4 and part of the incisor. NMC 15838 consists of LM_2-LM_3 and surrounding mandibular bone. It was excavated at Old Crow Locality 44 and may be of Sangamon interglacial age. NMC 24875 from Old Crow Locality 11A is a right mandible with RP_4 and alveoli for RM_1 and RM_2. Evidently it represents a small ground squirrel. NMC 24358 from Old Crow Locality 11A is a left mandible with the incisor lacking the tip. Alveoli for all cheek teeth are present. NMC 15816 from Old Crow Locality 44 is a left mandible with incisor and alveoli for the cheek teeth. It may be of Sangamon age. NMC 24988 from Old Crow Locality 11A is a right mandible with alveoli for the incisor and cheek teeth. The posterior part of the mandible including the angular process and condyloid process are preserved. NMC 22057 from Old Crow Locality 27W is a right mandible with part of the incisor and alveoli for the cheek teeth. NMC 28794 from Old Crow Locality 20 is a left mandible with part of the incisor and alveoli for the cheek teeth. NMC 22250 from Old Crow Locality 27W is a

right mandible with well-worn incisor and alveoli for the cheek teeth. NMC 18625 from Old Crow Locality 27 is a left mandible with alveoli for the cheek teeth. NMC 28654 from Old Crow Locality 136 is a right mandible containing the root of the incisor and alveoli for RP_4-RM_2.

Discussion

These are the first records of the arctic ground squirrel from the Pleistocene deposits of Canada. Several specimens excavated at Old Crow Locality 44 suggest that the species occurred in the Old Crow Basin at least as early as the ?Sangamon interglacial. The specimens from near Dawson are probably of late Wisconsin age.

Teeth of ?Nebraskan age from the Cape Deceit Formation, Alaska appear to be very similar to those of living arctic ground squirrels (Guthrie and Matthews 1971, p. 492). It is interesting to note that this species was the first small rodent described from Pleistocene deposits near Fairbanks (Hill 1942, p. 1842). Since then, it has been reported from deposits of Illinoian and Wisconsin age at other localities in Alaska (Repenning *et al.* 1964, p. 187-190, Guthrie 1968, p. 233).

Spermophilus evidently arose in North America during the early Tertiary as a result of expanding grass-

lands in the Great Plains region. With other ground squirrels *(Tamias, Marmota)*, *Spermophilus* first entered Eurasia from North America near the beginning of the Pleistocene (Thenius 1972, p. 174). Ground squirrels of the modern type first appear in Günz (?Nebraskan) deposits of Europe (Kurtén 1968, p. 196). Although more work is required to delineate the phylogenetic relationships of various species of *Spermophilus*, probably the Asian *S. undulatus* is closely related to *S. parryi*. On the basis of karyological data, Vorontsov and Liapunova (1973, p. 147) indicate that the latter species is amphi-Beringian and that it reached Asia during the Wisconsin glaciation. However, specimens possibly of this species have been recorded by Vangengeim (1961) from deposits on the Aldan River, Siberia, which are of probable Illinoian age, and by Sher (1971) from the Iedoma Suite in the Kolyma Lowland, which is of early Wisconsin age.

The arctic ground squirrel is the largest and most northerly of American ground squirrels. It is found from eastern Siberia to Hudson Bay, and southward to northwestern British Columbia. The fact that it is not found on any of the Canadian Arctic Islands indicates that it seldom travels very far over sea ice. The species is colonial and spends about seven months each year hibernating in dens between 24

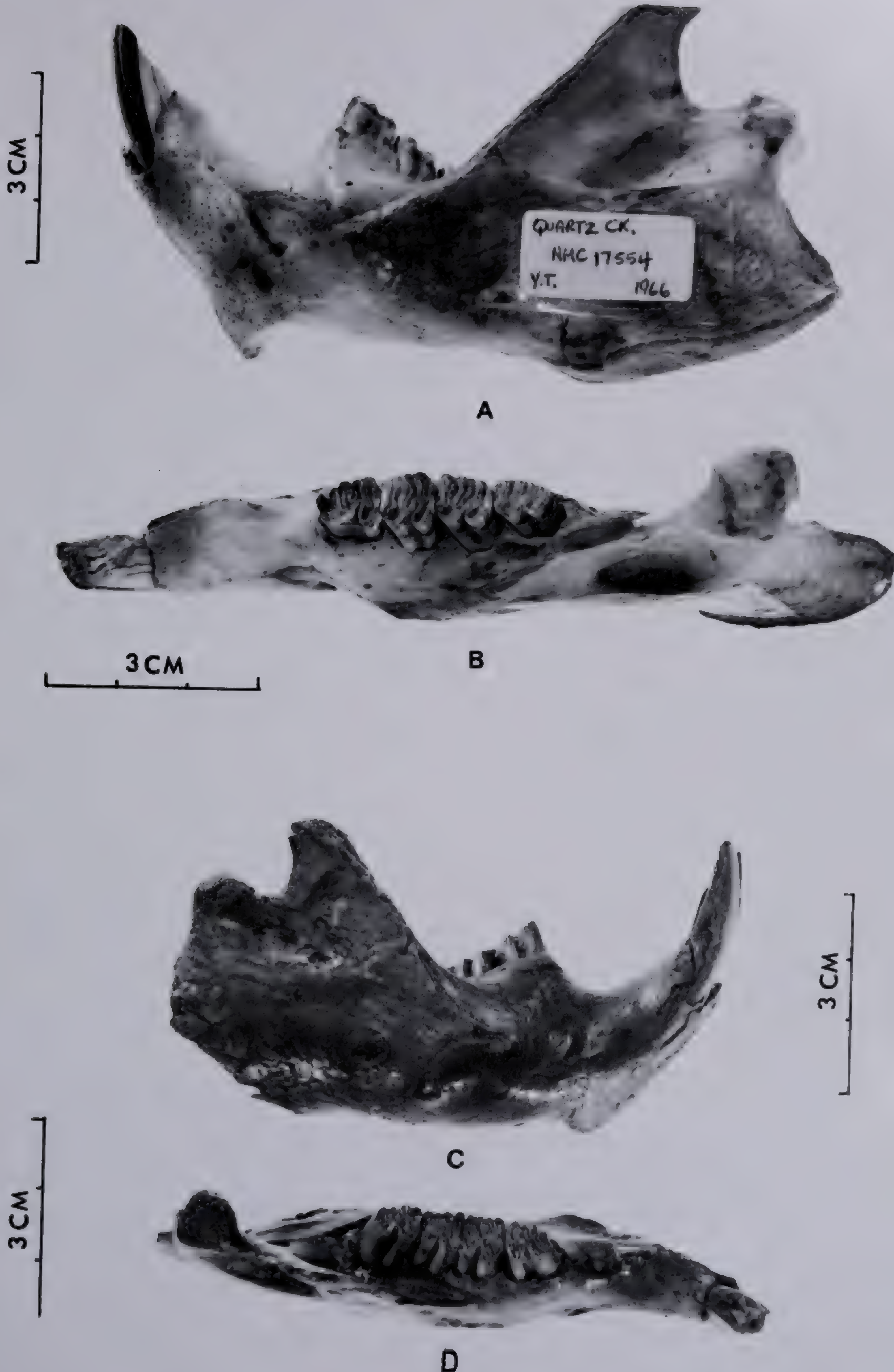
and 30 inches (36-76 cm) below the surface. *Spermophilus parryi* occupies tundra north of the tree line and clearings within northern forests. It is restricted to gravelly and sandy hillocks such as river banks, eskers and moraines, where good drainage prevents permafrost from occurring near the surface. Arctic ground squirrels eat a wide variety of tundra vegetation including grasses, forbs and woody species. In the late summer they cache seeds and leaves in their hibernation dens or in passages leading to them. This habit accounts for the presence of nests with grasses, seeds and fecal pellets found in late Pleistocene deposits near Dawson (e.g. NMC 21094). Arctic ground squirrels are an important part of the diet of the ermine, wolf, arctic fox, and grizzly bear.

Family Castoridae

Castor canadensis (beaver)

Many mandibles with teeth, but only a few maxillary fragments (Figure 15A-D, Tables 20-21) have been collected from Pleistocene deposits in the Old Crow Basin. A single mandible has been recovered from the Dawson Area of the Yukon Territory. This difference in incidence of specimens is attributed to greater abundance of standing water in the Old Crow Basin throughout the late Pleistocene compared to

Figure 15. Left mandible of a Pleistocene beaver *(Castor canadensis)* (NMC 17554, Dawson Locality 7). A. Lateral view. B. Occlusal view. Right mandible of a Pleistocene beaver *(Castor canadensis)* (NMC16407, Old Crow Locality 71). C. Lateral view. D. Occlusal view.


3CM
QUARTZ CK.
NMC 17554
Y.T. 1966
A
3CM
B
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C
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D

Table 20. Measurements of Pleistocene beaver (*Castor canadensis*) maxillae from the Yukon Territory compared to those of Recent beavers from the Yukon.

SPECIMENS	SEX	MEASUREMENTS (mm) *				
		1	2	3	4	5
Castor canadensis. Pleistocene, Old Crow, Y.T.						
NMC 13588 Loc. 11A	–	27.2	8.2	8.0	7.5	7.6
NMC 26671 Loc. 15	–	26.9	8.8**	8.4**	6.6†	8.1
Castor canadensis. Recent, Y.T.						
NMC 31754	–	27.2	8.3	8.5	6.9	7.8
NMC 31756	–	25.5	8.2	7.1	6.2	6.3
NMC 31755	–	25.9	7.2	7.3	6.0	7.1
NMC 31295	♂	26.6	6.8	6.2	6.2	6.5
NMC 36286	♂	27.8	7.4	7.7	6.3	7.3
NMC 31298	♀	27.3	8.1	7.7	6.2	6.9
NMC 31296	♂	25.4	7.3	6.9	6.2	6.3
NMC 31297	♂	27.2	8.2	7.8	6.6	7.0
NMC 36288	♂	31.1	11.0	8.9	6.4	8.0
NMC 36291	♂	27.2	8.1	7.7	6.3	6.9
NMC 37380	–	29.4	8.8	9.1	6.5	8.2
NMC 1953	♀	23.9	6.6	7.0	5.6	6.2

* 1. Maximum width between lateral alveolar margins of P^4. 2. Length occlusal surface (anteroposterior) P^4. 3. Width P^4. 4. Length M^1. 5. Width M^1. ** Measurements taken at alveolus.

Table 21. Measurements of Pleistocene beaver *(Castor canadensis)* mandibles from the Yukon Territory compared to those of Recent beavers from the Yukon.

SPECIMENS	SEX	MEASUREMENTS (mm) * 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Castor canadensis. Pleistocene, Yukon Territory.																	
NMC 17554 Quartz Creek Dawson Area.	–	102.4	93.4	23.3	33.6	25.0	17.7	8.7	7.0	9.1	7.4	7.6	8.5	7.9	7.6	7.9	6.3
NMC 19255 Old Crow Loc. 14	–	–	108.2	25.7	39.8	28.9	20.4	9.7	8.1	11.1	8.7	9.3	9.8	8.4	9.2	–	–
NMC 16302 Old Crow Loc. 60	–	–	95.0	23.7	33.9	25.9	21.0	–	–	8.5	7.2	8.2	8.2	7.3	7.9	8.1	6.6
NMC 16407 Old Crow Loc. 71	–	–	74.9	20.3	28.9	21.5	16.9	6.6	6.0	6.6	5.9	6.4	6.2	6.2	6.0	6.6	5.5
NMC 20729 Old Crow Loc. 22	–	–	–	22.5	36.6	24.4+	20.1	–	–	9.1	6.9	7.7	8.3	7.9	8.3	7.4	6.4
NMC 16993 Old Crow Loc. 20	–	–	–	24.2	34.2	24.7	19.8	–	–	9.5	6.6	7.7	7.1	7.6	7.0	8.4	6.4
NMC 16057 Old Crow Loc. 44	–	–	–	22.1	34.4	24.9	19.3	–	–	8.9	6.8	8.3	7.3	7.4	6.9	7.3	6.1
NMC 27165 Old Crow Loc. 29	–	–	–	24.1	36.3	26.6	20.6	8.6	7.2	10.4	7.4	8.3	8.6	8.0	8.5	7.8	6.8
NMC 26678 Old Crow Loc. 20	–	–	–	23.3	35.3	27.9	19.8	–	–	9.0	7.1	7.9	8.0	7.4	8.0	7.3	6.6
NMC 27871 Old Crow Loc. 87	–	–	–	22.8	36.2	27.6	21.8	–	–	10.2	8.4	8.4	8.4	8.1	8.1	8.4	6.9
NMC 24794 Old Crow Loc. 22E	–	–	–	22.6	36.1	28.9	18.2	8.0	6.9	10.0	7.6	7.7	7.9	7.5	7.8	–	–
NMC 18701 Old Crow Loc. 29	–	–	–	20.5	34.5	25.8	20.0	–	–	9.0	7.7	8.0	8.6	7.7	8.7	–	–
NMC 18301 Old Crow Loc. 29	–	–	–	23.6	–	24.8	–	–	–	8.7	8.2	8.0	9.4	8.1	7.9	–	–
NMC 26979 Old Crow Loc. 22	–	–	–	–	–	–	22.6	–	–	–	–	7.1	7.0	7.5	6.9	7.5	6.5
NMC 20298 Old Crow Loc. 29	–	–	–	24.1	35.2	–	19.2	–	–	9.6	7.9	7.7	8.9	8.1	8.0	–	–
NMC 26975 **Old Crow Loc. 22	–	–	–	23.5	35.0	–	22.1	–	–	–	–	7.9	8.6	7.5	7.5	9.0	6.3
NMC 18300 Old Crow Loc. 29	–	–	–	–	–	–	22.2	–	–	–	–	8.0	8.4	7.7	8.0	7.8	6.8
NMC 18260 Old Crow Loc. 11A	–	–	–	–	34.5	–	20.4	–	–	7.7	5.8	7.0	6.6	7.4	6.6	–	–
NMC 28295 Old Crow Loc. 136	–	–	–	–	–	–	–	–	–	–	–	8.2	7.9	7.7	7.6	8.0	6.4
NMC 18219 Old Crow Loc. 29	–	–	–	–	–	–	–	–	–	9.5	7.4	8.8	8.6	8.4	8.6	–	–
NMC 14808 Old Crow Loc. 29	–	–	–	–	–	–	–	–	–	–	–	7.6	7.7	8.1	8.2	–	–
NMC 27192 Old Crow Loc. 29	–	–	–	–	–	–	20.8	–	–	–	–	–	–	7.9	8.2	8.3	6.2
NMC 27328 Old Crow Loc. 29	–	–	–	–	–	–	–	–	–	–	–	8.2	7.9	8.2	7.6	–	–
NMC 24678 Old Crow Loc. 45	–	–	–	–	–	22.3	–	–	–	7.9	6.2	6.9	7.4	–	–	–	–
NMC 15574 Old Crow Loc. 28	–	–	–	23.9	–	23.7	–	–	–	9.7	7.5	–	–	–	–	–	–
Castor canadensis. Recent, Y.T.																	
NMC 31754	–	102.1	90.8	23.3	34.5	26.4	17.8	7.8	7.6	9.2	8.0	7.9	8.6	7.4	8.3	7.8	6.9
NMC 31756	–	93.6	81.8	22.0	31.8	26.7	17.5	7.8	6.8	8.4	6.1	6.6	6.2	6.5	6.4	7.2	6.0
NMC 31755	–	92.1	81.2	20.5	31.5	23.2	16.4	7.4	7.2	7.3	6.1	6.9	7.0	6.8	7.2	6.8	6.2
NMC 31295	♂	97.4	84.6	20.1	30.8	27.5	18.8	7.0	6.7	7.2	5.2	6.8	6.0	6.5	6.2	6.4	5.3
NMC 36286	♂	97.4	83.7	21.9	31.2	25.7	18.0	7.3	7.0	8.3	6.5	7.1	7.0	6.8	7.0	6.5	6.1
NMC 31298	♀	96.7	84.2	20.7	32.1	25.0	18.7	7.3	6.6	8.6	6.9	7.3	7.3	7.1	7.4	7.3	6.0
NMC 31296	♂	87.4	74.0	19.8	30.6	21.9	17.1	6.6	6.2	7.9	6.2	6.9	6.4	6.4	5.8	6.4	5.3
NMC 31297	♂	96.5	85.8	20.5	31.5	23.4	17.3	7.8	6.8	8.0	6.5	7.3	7.3	7.3	7.1	7.2	5.9
NMC 36288	♂	105.4	91.8	23.0	35.9	25.4	19.5	8.6	8.0	9.2	7.5	7.5	8.3	8.2	7.6	7.8	6.5
NMC 36291	♂	92.7	83.3	21.0	33.5	21.3	16.7	7.2	6.4	8.5	6.4	6.8	7.1	7.0	7.0	7.6	6.1
NMC 37380	–	98.1	88.7	22.0	33.6	24.0	18.1	7.4	7.4	9.0	6.9	7.6	7.4	7.4	7.3	7.6	6.1
NMC 1953	♀	88.1	76.0	20.0	29.8	22.6	16.2	6.2	6.4	7.4	6.3	6.6	6.0	5.7	6.0	6.1	5.5

* 1. Mandible length (superior alveolar margin of I_1 to posterior of angular process). 2. Mandible length (superior alveolar margin of I_1 to posterior of condyle). 3. Diastema depth (minimum distance across mental foramen to inferior margin posterior to symphyseal flange).

* 4. Alveolar length (P_4–M_3). 5. Diastema length (superior alveolar margin of I_1 to anterior alveolar margin of P_4) 6. Mandible depth at M_3. 7. Length (anteroposterior) of I_1. 8. Width of I_1. 9. Length P_4. 10. Width P_4. 11. Length M_1. 12. Width M_1. 13. Length M_2. 14. Width M_2. 15. Length M_3. 16. Width M_3.

** Teeth are very heavily worn.

the more alpine nature of Dawson Area during that period, and the relatively better drainage there. Specimens are stained brown unless otherwise noted.

NMC 13588 from Old Crow Locality 11A is an anterior maxillary fragment with RP^4-RM^1 and LP^4-LM^1. NMC 26671 from Old Crow Locality 15 is a maxilla with RP^4-RM^2 and LP^4-LM^2. Of these teeth, all are broken off at the alveolar margins except LM^1, which is nearly complete.

NMC 17554 from Dawson Locality 7 is a complete left mandible with all teeth. It is lighter in color than all other specimens described, being manila with patches of reddish brown and black - possibly due to iron and manganese staining respectively. The enamel surface on the anterior of the incisor is black rather than orange as in Recent specimens. The remaining specimens are from the Old Crow Area. NMC 19255 from Old Crow Locality 14 is a complete right mandible except that it lacks M_3 (the alveolus is present), the posterior margin of the angular process, and the tip of the coronoid process. Enamel on the anterior surface of the incisor is stained olive green. NMC 16302 from Old Crow Locality 60 is a left mandible with LP_4-LM_3 lacking the incisor. NMC 16407 from Old Crow Locality 71 on Johnson Creek is a complete right mandible with all teeth

except that the inferior and posterior (angular process) margins of the mandible are eroded. The small size of the specimen and the roughened surface of the condyle suggest the specimen represents an immature individual. A slight perforation on the lateral surface of the mandible exposes part of the base of RM_3- another indication that the specimen is from an immature beaver. NMC 20729 from Old Crow Locality 22 is a left mandible with LP_4-LM_3 and part of the incisor. NMC 16993 from Old Crow Locality 20 is a right mandible with RP_4-RM_3 and a broken incisor. NMC 16057 is a left mandible with LP_3-LM_3 and a broken incisor. It was excavated at Old Crow Locality 44 and may be of Sangamon interglacial age. NMC 27165 from Old Crow Locality 29 is a left mandible with LP_4-LM_3 and the incisor. NMC 26678 from Old Crow Locality 20 is a left mandible with LP_4-LM_3 and the alveolus for the incisor. NMC 27871 from Old Crow Locality 87 is a right mandible with RP_4-RM_3 and a broken incisor. NMC 24794 from Old Crow Locality 22E is a left mandible with LP_4-LM_2, the alveolus for M_3 and the incisor. The wear on the incisor is unusual in that its apex occurs on a ridge approximately 3 mm posterior to the enamel, rather than on the tip of the enamel surface itself. Both posterior and anterior-facing facets show signs of wear. Presumably this phenomenon resulted from a change in the bite of the jaws. NMC 18701 from Old Crow Locality 29

is a left mandible with LP_4-LM_2, the alveolus for LM_3 and a broken incisor. NMC 18301 from Old Crow Locality 29 is a right mandible with RP_4-RM_2 and a broken incisor. The anteromedial part of LM_1 is missing. NMC 26979 from the sand bar opposite to Old Crow Locality 22 is a left mandible with LM_1-LM_3. The condyle is present. The surface of the fossil suggests that it had been buried in heavily oxidized matrix. NMC 20298 from Old Crow Locality 29 is a left mandible with LP_4-LM_2 and the alveolus for LM_3. NMC 26975 from the sand bar opposite to Old Crow Locality 22 is a left mandible with LM_1-LM_3 and the alveolus for LP_4. The incisor is broken. The cheek teeth are so heavily worn that the flexids which usually appear are worn away, particularly on the posterior part of LM_3 and on the lingual margin of LM_1. NMC 18300 from Old Crow Locality 29 is a left mandible with LM_1-LM_3 and a partial alveolus for LP_4. Part of the incisor is within the mandible below the cheek teeth. NMC 18260 from Old Crow Locality 11A is a right mandible with RP_4-RM_2. The alveolus for RM_3 is barely discernible, being nearly obscured by oxidized sand. A fragment of the incisor lies beneath the cheek teeth. The teeth are high above the alveolar margin and are relatively narrow, suggesting that the individual represented may be rather young. NMC 28295 from Old Crow Locality 136 is a right mandible fragment with RM_1-RM_3. NMC 14808 from

Old Crow Locality 29 is a posterior fragment of a left mandible with LM_1-LM_2 and a partial alveolus for LM_3. Highly oxidized sandy matrix is seen on the exposed surface of the alveolus for the incisor. NMC 27192 from Old Crow Locality 29 is a posterior fragment of a right mandible with RM_2-RM_3. NMC 27328 from Old Crow Locality 29 is a right mandible fragment with RM_1-RM_2 and the alveolus for RM_3. NMC 24678 from Old Crow Locality 45 is an anterior left mandible fragment with LP_4-LM_1 and part of the incisor. Matrix adhering to the surface is oxidized sand. The specimen was collected *in situ* from a fine gray sandy gravel overlying the basal clay unit about 30 feet (9.1 m) above river level. I correlate this unit with Unit 2 at Old Crow Locality 44 and suggest that this specimen is of Sangamon age. NMC 15574 from Old Crow Locality 28 is an anterior fragment of a right mandible with RP_4 and part of the alveolus for the incisor.

Discussion

Evidently beavers (Castoridae) were present in the Old Crow Area from ?Yarmouth interglacial or earlier times to the present. The earliest evidence is from a basal unit of oxidized grit at Porcupine Locality 100 where many beaver-cut sticks - possibly the remains of a dam - were found. A beaver-cut stick was collected *in situ* from the basal clay at a point 15 feet (4.6 m) above the level of the Old Crow River at Locality 96. I suggest that this specimen is of

Illinoian age. In this connection, it is interesting to note that beaver dams and beaver-cut wood have been found in redeposited loess of Illinoian age in the valley of Sheep Creek near Fairbanks, Alaska (Péwé and Hopkins 1967, p. 268). Although beaver-cut sticks have been collected at many other localities in the Old Crow Basin, few were found in place and none has been radiocarbon dated. A well preserved mandible, NMC 16057, collected *in situ* from Unit 2 at Old Crow Locality 44, and another mandible, NMC 24678, from what I consider to be a correlative unit just upstream at Old Crow Locality 45, are of ?Sangamon interglacial age. Specimens of *Castor canadensis* other than NMC 16057 have been excavated from Unit 2 at Old Crow Locality 44. The mandible (NMC 17554) from Dawson Locality 7 is probably of late Wisconsin age. Sticks, almost certainly cut by *Castor canadensis*, from organic sediments near Arctic Red River, Northwest Territories yielded a radiocarbon date of 9,500 ± 90 years B.P. (GSC-1814). The species has also been described from the fauna at Acasta Lake somewhat farther east. That fauna has been radiocarbon dated at approximately 7,000 years B.P. (Noble 1971). Beaver-gnawed wood radiocarbon dated between approximately 9,000 and 4,000 years ago has been recorded from Cook Inlet, Tofty and Kotzebue areas in Alaska. Beavers presently occupy most of the Yukon Territory except for the arctic coastal

region (Youngman 1975, p. 77).

The genus *Castor* had its origin in the early Pliocene of Eurasia (Kurtén 1971, p. 147). The earliest North American record is of *Castor* sp. from Hemphillian deposits (Repenning 1967, p. 291). Presumably beavers like *Castor accessor* or *C. californicus* from Blancan deposits in western United States could have given rise to *C. canadensis* during the early Pleistocene. Both were approximately 10% larger than the living North American beaver, but were similar in gross characteristics of dentition and skeleton (Shotwell 1970, p. 30). A mandible of the modern beaver (*Castor* cf. *canadensis*) from sediments of probable Kansan age near Medicine Hat, Alberta is the earliest record for Canada (Stalker and Churcher 1971, p. 114). Hibbard (1970, p. 423) reports *C. canadensis* from Illinoian deposits of Kansas. This appears to be the earliest record from the Great Plains of the United States. *Castor canadensis* has been reported in Wisconsin age faunas from Cherokee Cave, Missouri and Samwel Cave, California, among others (Hibbard 1958, p. 15).

All European Pleistocene beavers of the genus *Castor* seem to be referable to *Castor fiber*. This species is recorded from Villafranchian to postglacial time there -

indeed, it has survived in parts of Scandinavia, in the Rhône and Elbe rivers and in eastern Europe. In Asia its range extends to Siberia and Mongolia. Although *C. fiber* and *C. canadensis* are closely related, Lavrov and Orlov (1973) showed karyotypical and craniological differences between the two species.

The beaver is Canada's largest and perhaps most distinctive rodent. Its characteristic morphological features are adaptations for swimming and feeding on woody vegetation. It is found throughout North America where there are wooded waterways such as lakes and slow-flowing streams where aspen and other suitable food occurs. Occasionally beavers can live where only shrub willows, alders or water plants provide food. In order to maintain a fairly constant water level around the lodge or bank den, a dam made of brush, cut trees and mud is constructed across a stream. Beavers are colonial. Most colonies consist of an adult pair, the new-born young and the young of the previous year, bringing the family to about 10 by autumn. Food consists mainly of the bark and twigs of trees, although many other plants are eaten, especially in summer. Bear, wolf, coyote, fisher, wolverine, otter and lynx prey on beavers. Man is also a most important predator, desiring pelts for clothing.

Castoroides ohioensis (giant beaver)

A few hundred teeth and largely fragmentary postcranial bones of the giant beaver have been collected from the Old Crow Basin. Cheek teeth and astragali are generally best preserved due to their toughness and compactness. Incisors break readily but even very small pieces of the ribbed enamel can be recognized. Of the specimens collected only two mandibles with teeth, a mandibular fragment and a few of the more substantial incisor fragments are described (Figures 16-18, Table 22). The patterns of lophids and flexids (Martin 1969, p. 1035) seen on the occlusal surfaces of the lower cheek teeth from the Old Crow Area have the "S" shape and the large size characteristic of *Castoroides*. A specimen of *Castoroides ohioensis* from postglacial deposits of Minnesota compares closely in morphology with mandibles from the Porcupine and Old Crow rivers and lies between them in size. Therefore, the Yukon Pleistocene specimens are referred to *Castoroides ohioensis*.

Referred specimens

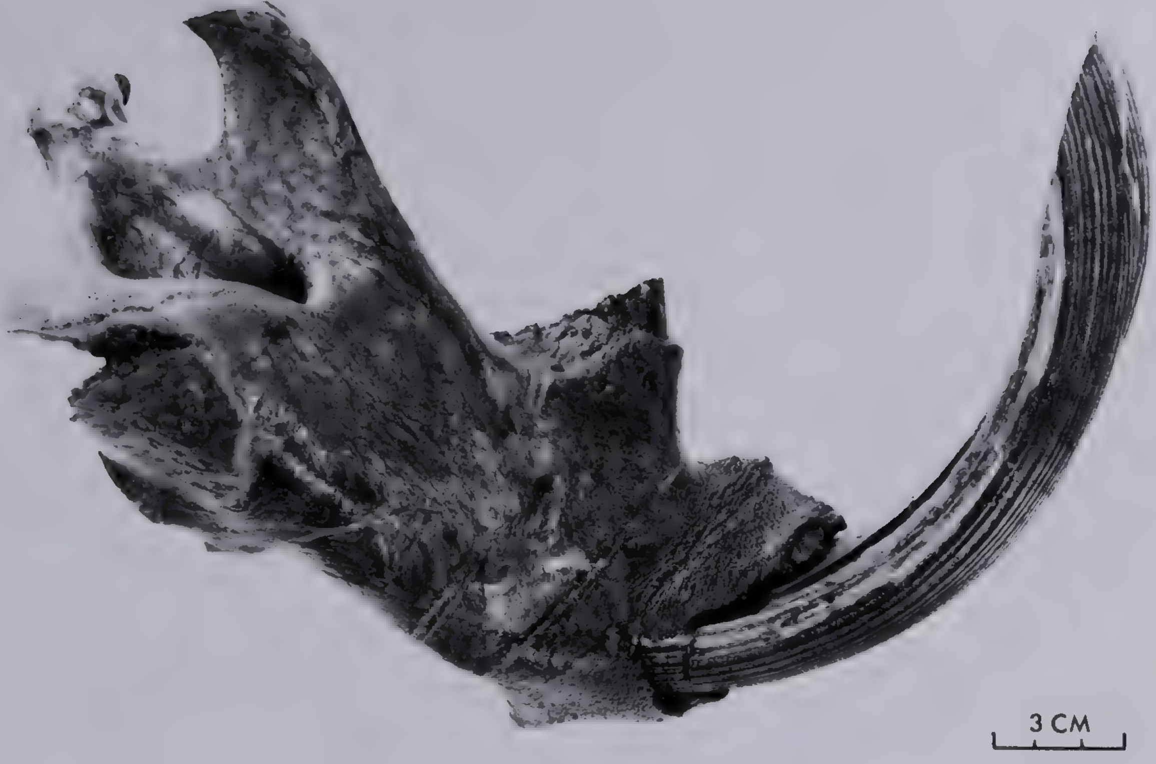
NMC 29418 is an upper incisor fragment as indicated by the robustness relative to lower incisors and the central depression running the length of the ribbed outer surface that characterize these teeth. Its maximum length and width are 25.8 mm and 26.2 mm respectively. It was excavated

Figure 16. Right mandible with RP_4 - RM_2 and incisor of a Pleistocene giant beaver *(Castoroides ohioensis)* (NMC 16587, Porcupine Locality 100).

A. Lateral view.

B. Occlusal view.

C. Medial view.



A

B

C

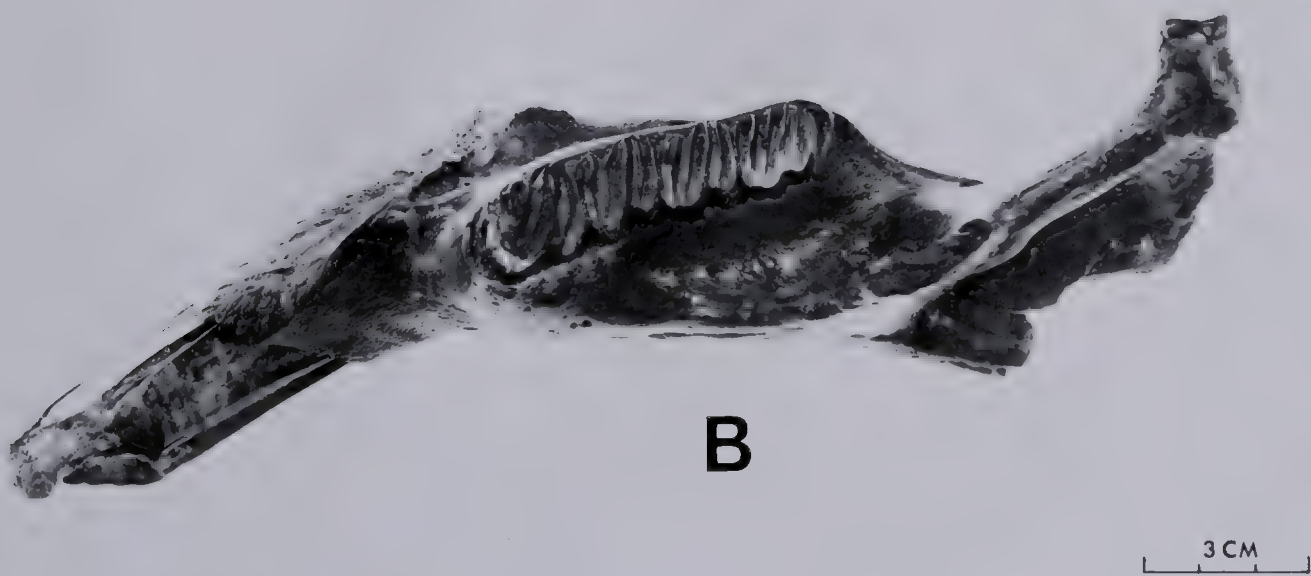
Figure 17. Left mandible with all teeth of a Pleistocene giant beaver *(Castoroides ohioensis)* (NMC 15333, Old Crow Locality 22).

A. Lateral view.

B. Occlusal view.

C. Medial view.

A



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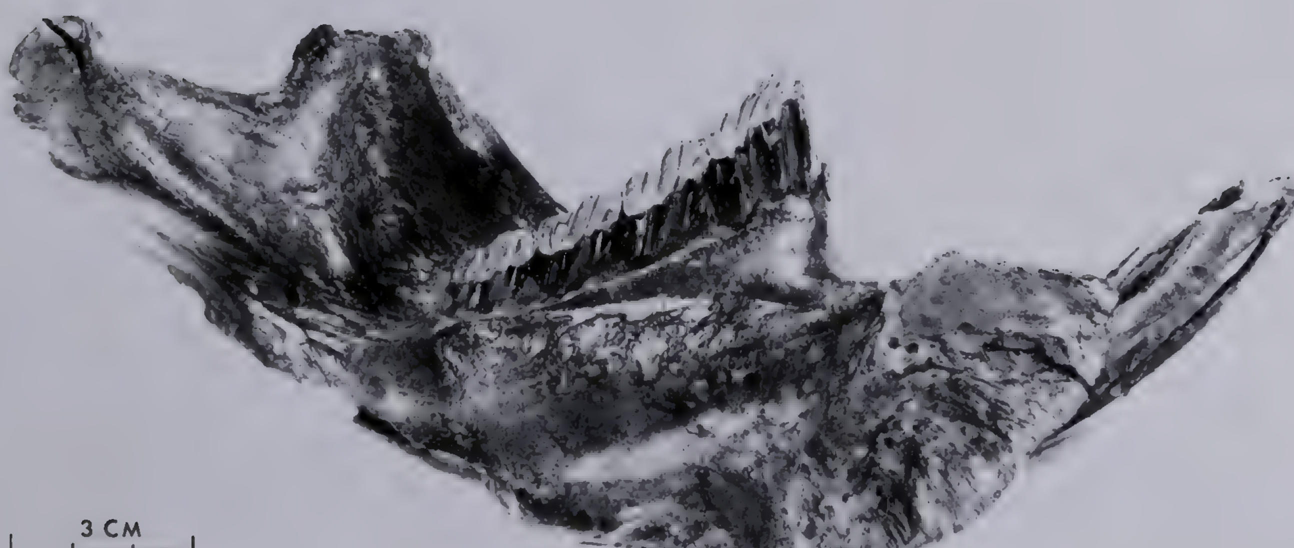


C

Figure 18. A. Restoration of a giant beaver *(Castoroides ohioensis)* as it may have appeared in its natural habitat in the Old Crow Basin during the late Pleistocene. In adulthood these animals reached over 7 feet (2.1 m) long and may have weighed as much as 480 pounds (218 kg). Note muskrat-like tail. Ink sketch by Charles Douglas. B. Detailed restoration of the head and forepart of the body of a giant beaver *(Castoroides ohioensis)*. Note the deep skull and ribbed cutting teeth. Ink sketch by Bonnie Dalzell.

A

B

Table 22. Measurements of Pleistocene giant beaver (*Castoroides ohioensis*) mandibles from the Yukon Territory compared to those of Pleistocene giant beavers from the United States.

SPECIMENS	MEASUREMENTS (mm) *															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Castoroides ohioensis. Old Crow, Y.T.																
NMC 16587 Porcupine Loc. 100	200.6	63.4	71.3	54.6	32.2	22.0	24.4	127.0	18.0	14.8	16.7	15.0	16.7	14.9	-	-
NMC 15333 Old Crow Loc. 22	181.8	52.6	64.3	53.6	-	20.7	20.4	41.0	18.3	13.8	15.4	13.4	14.4	12.6	13.3	12.6
NMC 14746 Old Crow Loc. 29	-	-	-	47.2	-	-	-	-	18.1	14.7	-	-	-	-	-	-
Castoroides ohioensis																
NMC 17691 (cast) Minnesota (left mandible)	178.7	56.4	70.4	52.8	27.1	22.0	21.2	107.0	18.3	13.6	16.7	13.9	15.7	13.3	** 14.2	** 12.6
Castoroides ohioensis dilophidus (Martin 1969, p. 1037). Florida																
Adult - Mean width of 18 incisors	-	-	-	-	-	-	24.8	-	-	-	-	-	-	-	-	-
Young - Mean width of 4 incisors	-	-	-	-	-	-	11.5	-	-	-	-	-	-	-	-	-
Castoroides ohioensis (Barbour 1931, p. 183)																
Indiana (Earlham College specimen).	-	-	-	-	-	-	-	-	20.0	12.0	17.0	13.0	17.0	13.0	16.0	12.0
Nebraska (No. 20-9-30)	-	-	-	-	-	25.0	20.0	-	19.0	16.0	16.0	16.0	17.0	15.0	-	-

* 1. Mandible length (superior alveolar margin of I_1 to posterior of condyle).
2. Diastema depth (minimum distance across mental foramen to inferior margin posterior to symphyseal flange).
3. Alveolar length (P_4-M_3).
4. Diastema length (superior alveolar margin of I_1 to anterior alveolar margin of P_4).
5. Mandible depth at constriction just posterior to M_3.
6. Length (anteroposterior) of I_1.
7. Width of I_1.
8. Inside length of I_1 from alveolar margin to tip.
9. Length P_4.
10. Width P_4.
11. Length M_1.
12. Width M_1.
13. Length M_2
14. Width M_2.
15. Length M_3.
16. Width M_3.

** Right mandible.

from oxidized organic sand overlying the basal clay unit at Old Crow Locality 29. NMC 13599 from Old Crow Locality 11A is a similar upper incisor fragment. Its maximum length and width are 24.5 mm and 26.7 mm respectively.

The most impressive specimen, which is now on display in the National Museum of Natural Sciences, is a right mandible (NMC 16587) with RP_4-RM_2, the alveolus for RM_3 and the complete incisor. The incisor is slightly cracked and warped. The thin bone of the posterior extremity of the angular process is missing. The specimen is stained blackish brown. I found the fossil on a narrow shelf at the base of the high bluffs at Porcupine Locality 100. It lay about 2 feet (0.6 m) above river level. In attempting to locate its source, directly above the site approximately 12 feet (3.7 m) above stream level, I found a black organic layer consisting of vegetative litter exposed just below some slumped surface material. Although I suspect that the mandible was derived from this organic layer, there is no way to prove it. Except in its larger size, the mandible differs in no important respect from a cast of a *Castoroides ohioensis* mandible (NMC 17691) from Hennepin County, Minnesota. B.R. Erickson, who kindly donated this cast to the National Museums of Canada, estimates that the original specimen (SMVP P69.21.1) is about

8,000 years old. The size of NMC 16587 and the fact that the occlusal surfaces of the cheek teeth show complete flexids, indicate that it represents an adult.

NMC 15333 from Old Crow Locality 22 is a left mandible with all teeth. Most of the coronoid process and the angular portion of the jaw are missing. The incisor is split and slightly warped. NMC 15333 is noticeably smaller than NMC 16587, but its most striking feature is the short incisor, which is 32% of the length of the Porcupine specimen and 38% of the length of the Minnesota fossil. Despite its relatively small size, the fact that the flexids are complete and the cheek teeth are greater than 12.5 mm in occlusal length indicates that NMC 15333 represents an adult. Furthermore, young *Castoroides'* incisors are approximately half the width of adult incisors (Martin 1969, p. 1036), whereas the Old Crow specimen is closest to the width of adults. I cannot account for the unusual shortness of the incisor, but speculate that it has undergone extremely heavy wear. The cutting facet is normal in every respect: there is no indication that the tooth had been broken. The mandible is stained dark brown.

NMC 14746 from Old Crow Locality 29 is an anterior portion of a left mandible with LP_4, the top of which has

been broken off near the alveolar margin. It is more robust than the corresponding part of NMC 15333, and the LP_4 is wider. In these respects it is closer to the large mandible from the Porcupine River. It is dark brown.

Discussion

The specimens from Old Crow Basin constitute the most northerly record of *Castoroides ohioensis* in North America. Fossils of this species have not been found elsewhere in the Yukon Territory or in Alaska. Although the Porcupine River specimen could be older, fossils (e.g. an incisor tooth NMC 16056) excavated from Old Crow Locality 44 indicate that giant beavers occupied the Old Crow Basin prior to 54,000 years ago - possibly during the Sangamon interglacial. *Castor canadensis* fossils were found in the same stratigraphic unit at Old Crow Locality 44, indicating that giant and modern beavers lived in the same region and were approximately contemporaneous. To explain their co-existence, I postulate that giant beavers occupied large lakes and ponds, while the modern beavers dammed slow-flowing streams in the region. The fact that all *Castoroides* specimens recovered so far are deeply stained suggests that the species became extinct in Eastern Beringia prior to the late Wisconsin. Could the relative coolness and dryness of the environment during the peak of the Wisconsin have resulted in their withdrawal from the region

or in their local extinction?

The only other Canadian fossil of *Castoroides ohioensis* is an incisor tooth from the Don Formation of Sangamon interglacial age in Toronto. Perhaps giant beavers were able to disperse rather rapidly northward into the Yukon from the southern part of North America through chains of lakes which evidently tend to form along the southern margin of the Canadian Shield during interglacial phases (e.g. the present interglacial). I suggest that the most likely time of this northward radiation would have been at the beginning of the Sangamon interglacial when the Illinoian ice sheet was melting back.

Two beavers that are of great importance when considering the ancestry of *Castoroides* are *Dipoides* and *Procastoroides*. *Dipoides* is known from the Pliocene of Eurasia and the middle Pliocene and Pleistocene of North America, while *Procastoroides sweeti* from the Rexroad fauna (early Blancan) of Kansas is intermediate between *Dipoides* and *Castoroides* in morphology of the cheek teeth and size, but it lacks the ribbed incisors characteristic of the latter genus. However, Shotwell (1970, p. 36) supplies a critical piece of information in his description of a new species, *Procastoroides idahoensis*, from the Grand View fauna

(Blancan) of Idaho: "The new species differs from *P. sweeti* primarily in the numerous longitudinal grooves {= ribs}, on the incisors much like those in *Castoroides*." This observation breaks down many objections to the *Procastoroides* - *Castoroides* sequence of evolution. I wish to stress the steady increase in size from *Dipoides* to *Castoroides*, and to put forward the hypothesis that as the incisors lengthen, they reach a point where extra structural support is necessary. I see this transition occurring between the *Procastoroides sweeti* and *P. idahoensis* stages, and taking the form of ribbing on the anterior surface of the incisors of the latter species and *Castoroides* providing extra support to those very important teeth. Indeed, this may have been one of the slight advantages that allowed *Castoroides* to replace *Procastoroides* in late Blancan time. In summary, I concur with Shotwell (1970, p. 39) that the phyletic line *Dipoides* - *Procastoroides* - *Castoroides* is the most probable sequence. It is interesting to note in this regard that Martin's (1969, p. 1040) study of *Castoroides* material from Florida showed stages of dental ontogeny suggesting a succession from a *Dipoides*-like molar pattern to that of adult *Castoroides* teeth in which the flexids are complete. Other possible origins for *Castoroides* are discussed by Woodburne (1961).

Although Eurasian giant beavers *(Trogontherium)* are known from Villafranchian to middle Pleistocene time in Asia, and from the Villafranchian to the Holstein (?Yarmouth) interglacial in Europe (Kurtén 1968, p. 198), Dechaseaux (1967) concluded that *Trogontherium* and *Castoroides* are at extreme ends of two markedly different branches of evolution. The Eurasian giant beaver, despite some similarities to *Castoroides* and the fact that it may have filled a similar ecological niche in relation to *Castor*, was only slightly larger than the modern beaver.

Castoroides was confined to North America. *Castoroides ohioensis* had become well established by Illinoian time and has been reported from late Pleistocene deposits from Florida to Ontario and New York to the Yukon Territory. During the retreat of the Wisconsin ice, many giant beavers lived in moist habitat south of the Great Lakes, particularly in the region covered by the present states of Indiana, Ohio and Illinois. *Castoroides ohioensis* evidently became extinct in postglacial time. Bone from a skeleton from Ramsay County, Minnesota yielded a radiocarbon date of 10,320 ± 250 years B.P. (Erickson 1967, p. 2).

Giant beavers reached the size of black bears - 7 feet (2.1 m) or more in total length, compared to approximately

3 feet (0.9 m) in the modern beaver, *Castor canadensis*. They may have weighed as much as 480 pounds (218 kg), compared to about 60 pounds (27 kg) for the modern beaver (Stirton 1965, p. 273). Unlike modern beavers, giant beavers had long incisors with ribbed anterior enamel surfaces. Stirton (1965, p. 274) remarks: "The construction of their incisors and the length that they extended beyond the alveolar borders, however, do not support the idea that these giant beavers felled larger trees or built dams." Although they may not have been able to build dams, I see no reason why giant beavers were unable to cut wood efficiently. I think the deeply ribbed enamel on the outer surface of the incisors would have acted as girdering. If they merely used their teeth for rooting out soft marsh plants, then why the massive size of the cutting teeth, why the deepened mandible with larger rather heavily ridged cheek teeth, and above all, why the relatively deeper masseteric fossa implying greater chewing and biting power? The extremely heavy wear on the incisor of NMC 15333 is worth considering again. Most likely the heavy wear was a result of cutting wood rather than feeding on softer aquatic plants. Nor does Stirton's observation that the tips of the giant beaver incisors are more rounded when seen from behind, compared to the flatter, chisel-like edge of modern beaver incisors, convince me that the former could not have filled

the combined role of wood cutters and gougers.

According to comparative studies of caudal vertebrae (Hay 1914), giant beavers had roundish, muskrat-like tails. This suggests that they were unable to use their tails to give alarm by slapping the water as modern beavers do. Perhaps they did not need an alarm signal! Although the hind limbs of *Castoroides* were well adapted for swimming, they are relatively short compared to *Castor* (Erickson 1962, p. 12), and considering the great weight of the animals, their ability to disperse overland, as some modern beavers do, would have been reduced (Cahn 1932, p. 238).

A possible giant beaver "lodge" was discovered by Williamson (1912) near New Knoxville, Ohio. Evidently a cranium of *Castoroides* and the den were in a peaty layer surrounded by humus. The den was said to be about 4 feet (1.2 m) high and 8 feet (2.4 m) square. It was made of willow poles approximately 3 inches (7.6 cm) in diameter.

Giant beavers evidently preferred lakes and ponds bordered by swamps as their habitat, for their remains have so often been found in ancient swamp deposits (Barbour 1931, pp. 172-174). The eventual reduction of these environments, perhaps linked with the inability to build dams

like those of *Castor canadensis* and the inability to disperse readily overland to new drainage systems when drought occurred, may have resulted in their extinction and the ultimate dominance of the smaller modern beaver in North America. Likewise, the Eurasian giant beaver *Trogontherium* gave way to *Castor fiber*, but earlier. It is unusual that there is no evidence that giant beavers were hunted by man. Evidently they co-existed. Surely a *Castoroides* pelt would have made an excellent coat or sleeping robe!

Family Cricetidae

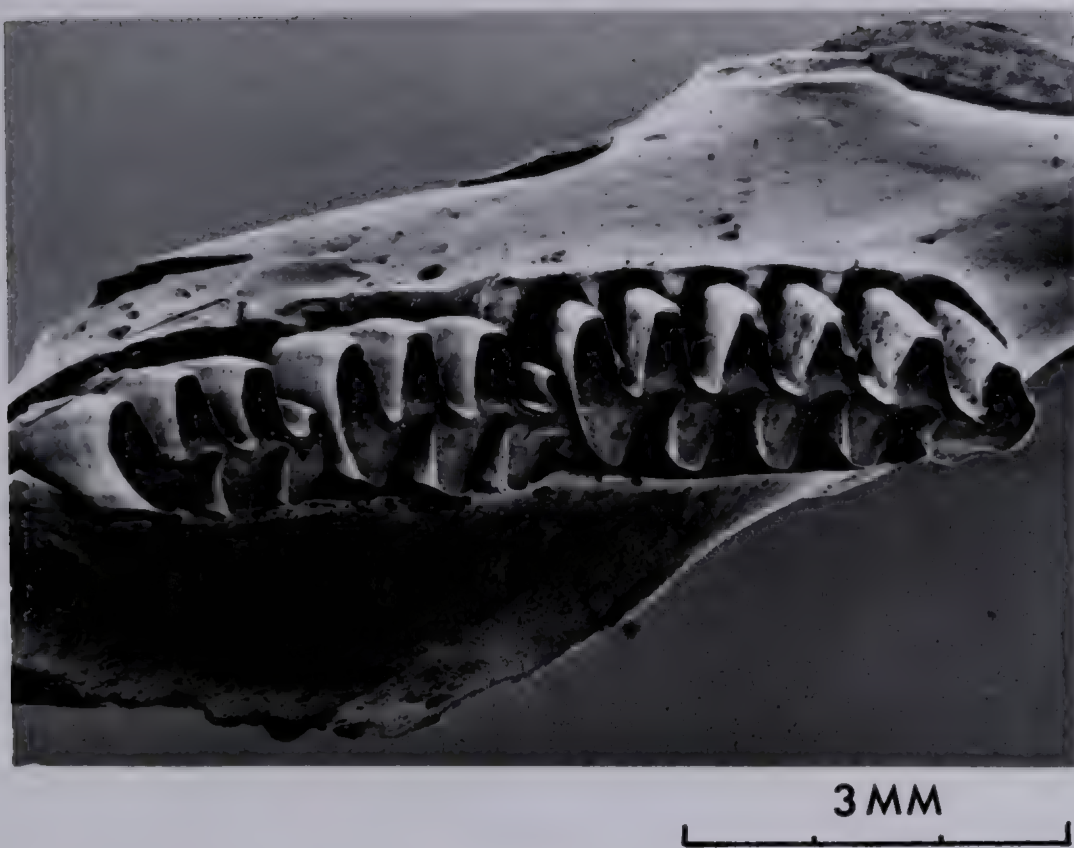
Dicrostonyx cf. *henseli* (Hensel's lemming)

A maxillary fragment and several mandibles with teeth (Figure 19A) from localities in the Old Crow Basin appear to be best referred to *Dicrostonyx* cf. *henseli*, which has a less complex tooth crown pattern than the collared lemming, *D. torquatus* (Hinton 1926). The point of greatest diagnostic importance in separating these specimens from fossils of the more common collared lemming is the lack of an anterior labial bud on M_3. Thus, *D. henseli* has a posterior loop and four salient angles in addition to an anterior lingual bud, as figured in Guthrie and Matthews (1971, p. 486). However, identification is not necessarily clear-cut because of the degree of variability in *Dicrostonyx*

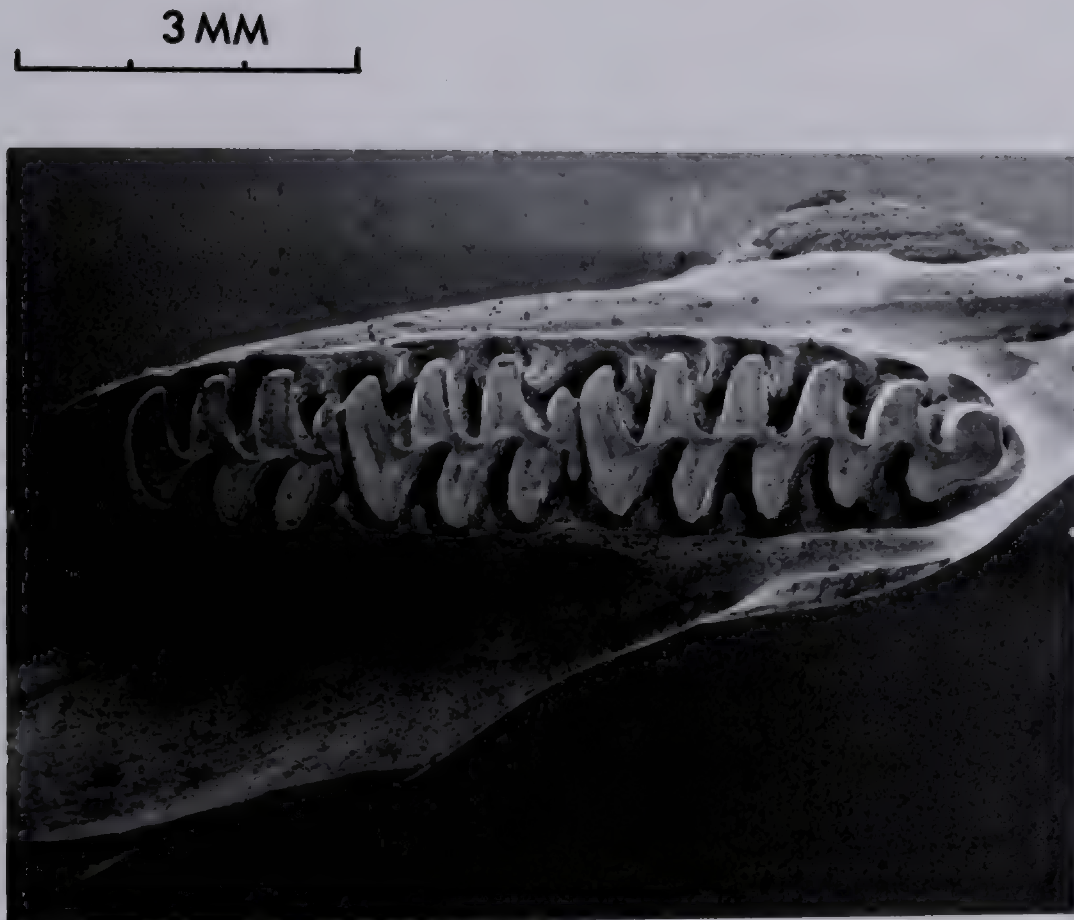
Figure 19. A. Occlusal view of RM_1-RM_3 in a right mandible (NMC 22219, Old Crow Locality 27W) of a Pleistocene Hensel's lemming *(Dicrostonyx* cf. *henseli).* SEM photograph.

B. Occlusal view of RM_1-RM_3 in a right mandible (NMC 18561, Old Crow Locality 29) of a Pleistocene collared lemming *(Dicrostonyx torquatus).* SEM photograph.

C. Occlusal view of LM_1-LM_3 in a left mandible (NMC 37802) of a Recent collared lemming *(Dicrostonyx torquatus)* from northern Canada. Note apparent lack of an anterior labial bud on M_3, as in *Dicrostonyx henseli*, suggesting the plasticity of what has been considered a "diagnostic" character of the latter species.



A



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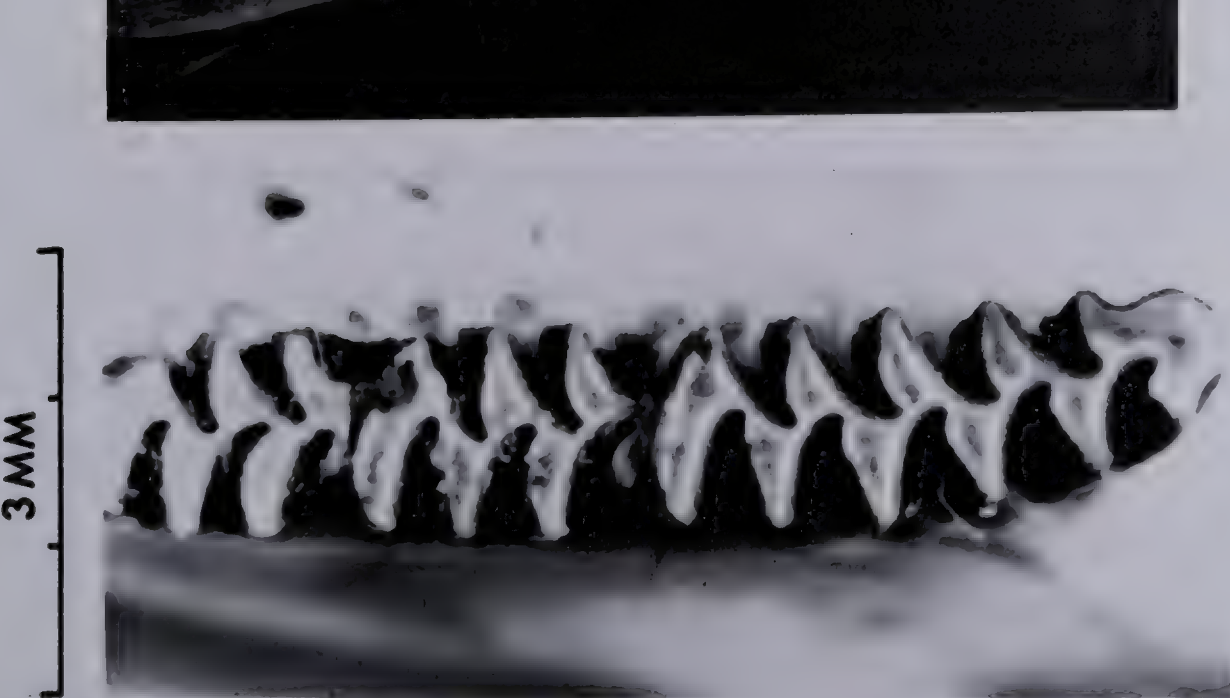


C

tooth patterns (Guilday 1968, p. 66; Agadzhanyan 1973, p. 339), and the problem must be investigated in detail - particularly in living *D. torquatus*. This problem is brought sharply into focus in observing a left mandible with incisor and LM_1-LM_3 of *Dicrostonyx* sp. from Old Crow Locality 27W which has an anterior loop of LM_1 like that of *D. torquatus*, whereas LM_2 and LM_3 are most like *D. simplicior* or *Predicrostonyx hopkinsi*, as illustrated by Guthrie and Matthews (1971, p. 486). All specimens are stained dark brown.

Studies based on comparative measurements of most of the cricetid rodents are deferred until suitably detailed statistical analyses of the large masses of data available can be made.

<u>Referred specimens</u>

NMC 15638 from Old Crow Locality 28 is a maxilla with LM^1-LM^2 and RM^1-RM^2 and palate. M^1s have posterior buds (small folds) on the labial side like those of *Dicrostonyx henseli* or *D. hudsonius* (the living Ungava lemming), while M^2s lack posterior buds entirely, consisting only of anterior loops and four triangles, being closest in this feature to *Predicrostonyx hopkinsi* (Guthrie and Matthews, p. 486). Unfortunately, M^3s are lacking so the

pattern of the posterior trefoil or loop which is of diagnostic importance cannot be used to more precisely identify the specimen. Pending further evidence, I refer this specimen to *D.* cf. *henseli*, and suggest that the lack of posterior buds on M^2s is an aberrant situation indicating a substantial degree of genetic plasticity.

NMC 22219 from Old Crow Locality 27W is a right mandible with the incisor and RM_1-RM_3. The ascending ramus is lacking. NMC 24411 from Old Crow Locality 11A is a left mandible with the incisor and LM_1-LM_3. NMC 22093 from Old Crow Locality 27W is a left mandible with the incisor, LM_3 and alveoli for LM_1-LM_2.

Discussion

The dark staining of the Old Crow fossils suggest a pre- late Wisconsin age, but beyond that nothing can be said, for they were not found *in situ* in one of the thicker sections along Old Crow River. In North America, this species has been reported previously only from the Deering Formation at Cape Deceit, Alaska. Guthrie and Matthews (1971, p. 501) consider that the sediments containing *D. henseli* were laid down during early Illinoian time. Hensel's lemming is known from many European Pleistocene localities and is closely related to the living Ungava lemming *(Dicrostonyx hudsonius)* of North America, which is restricted to tundra east of

Hudson Bay. Indeed, I am not sure how the two species can be distinguished! It appears that lemmings of the *D. henseli-hudsonius* type were widespread in Eurasia and North America before they were replaced everywhere except Ungava by the more complex-toothed collared lemming.

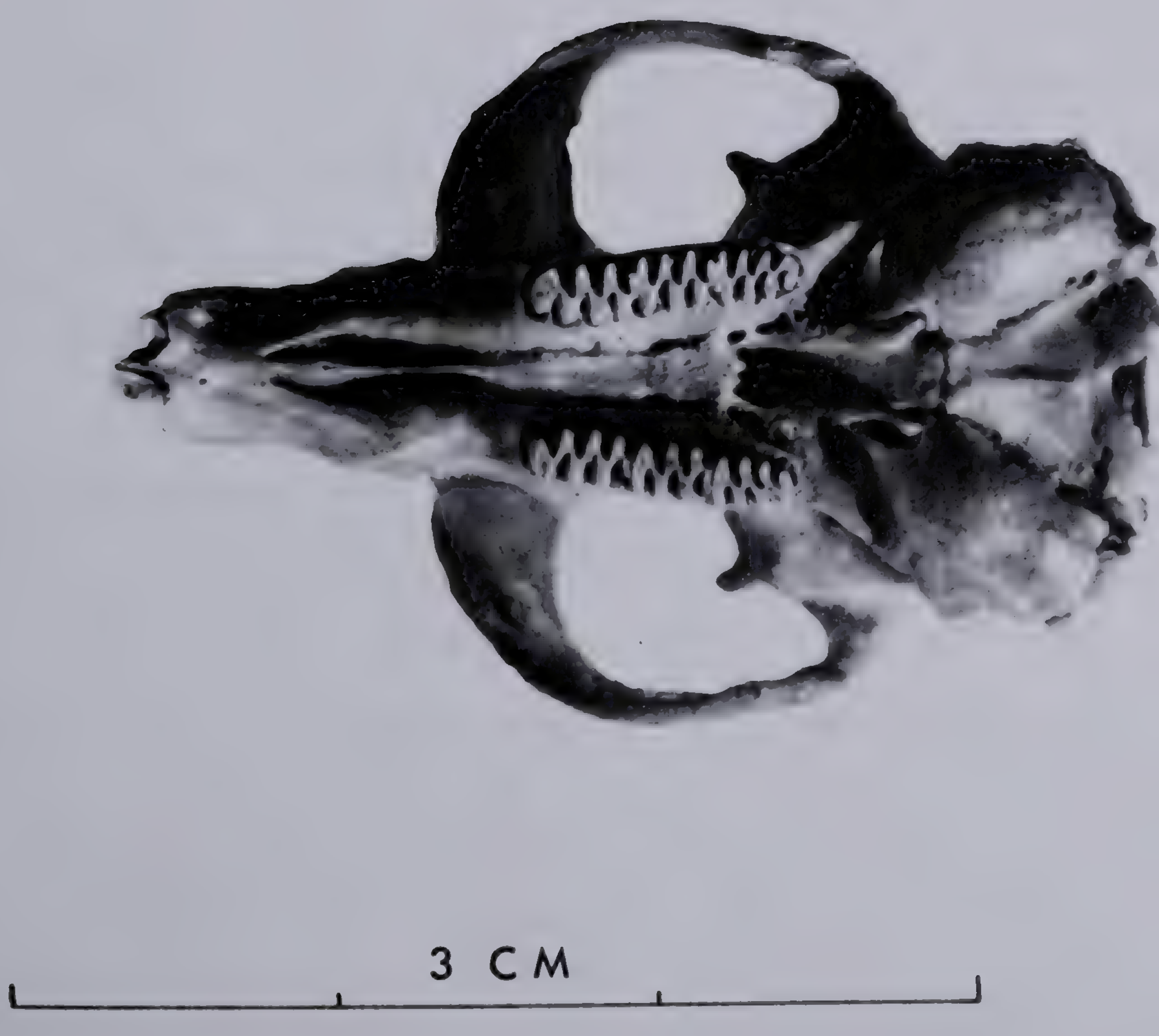
Perhaps the appearance and habits of *D. henseli* can be loosely compared to the living Ungava lemming, which is white in winter, and in summer is brownish to grayish above with a dark gray dorsal stripe. Like the collared lemming, it occupies tundra and fluctuates rather dramatically in population size, which in turn affects vitally its many predators such as the arctic fox and Snowy Owl.

Dicrostonyx torquatus (collared lemming)

A well preserved cranium from the Sixtymile Area and many mandibles with teeth (Figure 19B-C, 20A-B) from the Pleistocene deposits of the Old Crow Basin have been collected. These specimens generally fit the occlusal pattern for the collared lemming illustrated by Guthrie and Matthews (1971, p. 486) and Banfield (1974, p. 182). Not only skeletal elements but also fecal pellets of lemmings have been found in Yukon Pleistocene deposits. One large sample from frozen muck was excavated *in situ* 16 feet

Figure 20. Cranium (NMC 12062, Sixtymile Locality 1) of a Pleistocene collared lemming (*Dicrostonyx torquatus*). A. Dorsal view. B. Ventral view showing occlusal pattern of upper molar teeth.

A



B

(4.9 m) above the surface of the gold-bearing gravel in the Dawson Area. A lens of ground ice was situated below these droppings. I intend to have the pellets examined by paleobotanists in order to find out about the diet of late Pleistocene collared or brown lemmings.

Referred specimens

NMC 12062 is a complete cranium which was collected *in situ* at a mining cut at the mouth of Miller Creek where it enters the Sixtymile River (Sixtymile Locality 1). The muck layer at the locality was from 8 to 12 m thick overlying gold-bearing gravel. The rodent burrows from which the specimen came were exposed on the muck face 3 to 6 m below the surface. Several of the chambers contained remains of a nest, fecal pellets, and seeds. Skulls and skeletons of the rodents were found in some of the chambers. The specimen is estimated to be at least 10,000 years old (Porsild *et al.* 1967, p. 113).

NMC 18561 from Old Crow Locality 29 is a right mandible with RM_1-RM_3, the complete diastema and a large part of the ascending ramus. It is stained reddish brown. The following specimens are left mandibles with RM_1-RM_3: NMC 28640 (Old Crow Locality 65), NMC 22182 (Old Crow Locality 27W), NMC 24819 (Old Crow Locality 20), NMC 24680 (Old Crow Locality 11A). NMC 15714 from Old Crow Locality

28 has the incisor and RM_1-RM_3. NMC 19243 is a left mandible with LM_1-LM_3. It was excavated from the fossiliferous layer of Unit 2 at Old Crow Locality 44, which may be of Sangamon interglacial age. NMC 24419 from Old Crow Locality 11A is a left mandible with LM_1-LM_3. NMC 18841 from Old Crow Locality 20 is a left mandible with the incisor and LM_1-LM_2. NMC 28729 from Locality 27 is a left mandible with incisor and LM_1-LM_2. The following specimens are left mandibles with LM_1-LM_2: NMC 25275 (Old Crow Locality 27W), NMC 25070 (Old Crow Locality 20). NMC 25495 is a left mandible with LM_1-LM_2. It was screened from matrix excavated from Unit 2 at Old Crow Locality 44 and consequently may be of Sangamon age. NMC 25490, a left mandible with LM_1 and a fragment of LM_2, was also excavated from Old Crow Locality 44. Also excavated from that site is NMC 15840, which consists of a right mandible with RM_1-RM_2. NMC 25017 from Old Crow Locality 11A is a right mandible with RM_1-RM_2. Most of the diastema is present.

NMC 24813 from Old Crow Locality 20 is a right mandible with RM_1-RM_2. NMC 22190 from Old Crow Locality 27W is a right mandible with the incisor just projecting through its alveolar margin and RM_1-RM_2. The relatively small size of the specimen and the spindly incisor develop-

ment indicate it represents an immature individual. The deep reentrant on the lingual side of the anterior loop of RM_1 is unusual compared to the more normal condition seen in the fossil NMC 24704. The following specimens are right mandibles with RM_1-RM_2: NMC 25304 (Old Crow Locality 27W), NMC 18877 (Old Crow Locality 20), NMC 28817 (Old Crow Locality 20). NMC 22412 from Old Crow Locality 11A is a right mandible with a damaged RM_1 and complete RM_2. NMC 18648 from Old Crow Locality 27 is a right mandible with RM_1-RM_2 and the alveolus for RM_3. It is stained reddish brown. NMC 25086 is a right mandible with RM_1-RM_2. It was excavated from organic silts lying in a basin on the surface of the basal clay at Old Crow Locality 64, which I correlate with Unit 2 at Old Crow Locality 44. NMC 24413 from Old Crow Locality 11A has RM_1 and RM_3. Most of the diastema is present. NMC 15635 from Old Crow Locality 28 is a right mandible with long incisor and RM_1. NMC 19172 from Old Crow Locality 28 is a right mandible with long incisor and RM_1. NMC 19172 from Old Crow Locality 28 is a right mandible with RM_1, the alveolus for RM_2 and a damaged RM_3. NMC 18873 from Old Crow Locality 20 is a left mandible with LM_1 and the anterior half of LM_2. NMC 22070 from Old Crow Locality 27W is a small left mandible with LM_1-LM_2. It is stained black and the anterior loop of LM_1 is slightly damaged.

NMC 24704 from Old Crow Locality 11A is a right mandible with the incisor and RM_1. NMC 19253 is a right mandible with RM_1. It was excavated from Old Crow Locality 44 and may be of Sangamon interglacial age. NMC 22185 from Old Crow Locality 27W is a right mandible with RM_1. NMC 22067 from the same site is a right mandible with RM_1. NMC 24686 from Old Crow Locality 11A is a right mandible fragment with RM_1. NMC 25025 from Old Crow Locality 11A is a right mandible with RM_1. NMC 16169, a left mandible with LM_2, was excavated from organic silts overlying the basal clay at Old Crow Locality 45 which are probably correlative with Unit 2 at Old Crow Locality 44. NMC 22175 from Old Crow Locality 27W is a left mandible with the incisor and LM_1. The following specimens are left mandibles with LM_1: NMC 22091 (Old Crow Locality 27W), NMC 19174 (Old Crow Locality 28), NMC 28826 (Old Crow Locality 20), NMC 25019 (Old Crow Locality 11A). NMC 18572 from the sand bar at Old Crow Locality 29 is a left mandible with LM_1 and alveoli for LM_2-LM_3. NMC 25023 from Old Crow Locality 11A is a left mandible with LM_2 and part of the ascending ramus. NMC 22146, 22217 and 22287 from Old Crow Locality 27W are left mandibles with LM_1. Based on its very small size, the last represents a juvenile.

Discussion

Several mandibles excavated from organic deposits

overlying the basal clay unit at Localities 44, 45 and 64 indicate that collared lemmings may have lived in the Old Crow Basin as early as the Sangamon interglacial. The cranium from Miller Creek is probably of late Wisconsin age. The only other specimens from Canada are from post-glacial deposits on the northern coast of Ellesmere Island, Northwest Territories (Fielden and DeRance 1873; Harington 1971a).

In Alaska, *Dicrostonyx torquatus* seems to occur earlier than anywhere else, although the specific identification of material from interglacial (?Yarmouth) deposits laid down prior to the Illinoian glaciation in the Kotzebue Sound area should be checked (Péwé 1975a, p. 96). Fossils of this species are also known from Illinoian and Wisconsin deposits near Fairbanks (Guthrie 1968, p. 232), and from probable Illinoian sediments at Cape Deceit (Guthrie and Matthews 1971). Collared lemming fossils from Tofty are probably of Wisconsin age (Repenning *et al.* 1964, p. 196).

The relatively simple, generalized molar patterns of *Predicrostonyx hopkinsi* indicate that it is ancestral to *Dicrostonyx*. In addition, it has many incipient dental features that are emphasized in *Dicrostonyx* (Guthrie and

Matthews 1971, p. 488), and it is known from geological deposits that are sufficiently early (?Nebraskan) to allow evolution towards *Dicrostonyx*. *Dicrostonyx simplicior* appears to be the most primitive member of the genus. It lived during the cold phase of the Mindel (?Kansan) in central Czechoslovakia. The next stage, in which dental patterns are more complex, is the *D. henseli-hudsonius* phase. Lemmings in this group are known from Riss (Illinoian) or pre- Riss deposits near Cologne, Germany (Fejfar 1966), and from the beginning of the Dnepr (early Illinoian) at the Likhvin sections near Tula and Yaroslov in the Soviet Union (Agadzhanyan 1973, p. 333). The records from the Deering Formation at Cape Deceit, Alaska and from the Old Crow Basin, Yukon Territory have been mentioned previously: they are probably of Illinoian and pre- late Wisconsin age, respectively. It is most interesting to note the presence of two types of *Dicrostonyx*, one like *D. torquatus* (called *D. gulielmi*) and the other like *D. henseli* from Würm (Wisconsin) sediments in the Carpathian Basin. Although Janossy (1954) considers them to be extreme varieties of *D. torquatus*, I suggest that they mark the change from the *D. henseli-hudsonius* phase to the more advanced *D. torquatus* phase in this particular region. This change evidently occurred earlier in Beringia, as might be expected if the main evolution and radiation of

the group took place there. What happened in western Beringia?

Two types of *Dicrostonyx* have been recorded from the Olyor Suite of ?Kansan age in the Kolyma Lowland (Sher 1971). *D. torquatus* did not become the dominant collared lemming in northeastern Siberia until the Illinoian (e.g. the Utka Beds of the Kolyma Lowland and the Aldan River second terrace deposits described by Sher (1971) and Vangengeim (1961) respectively). *D. torquatus* has also been recorded from Illinoian to Wisconsin age deposits on southern Bolshoi Lyakhov Island (Vangengeim 1961) and from the early Wisconsin Iedoma Suite of the Kolyma Lowland (Sher 1971).

The late Pleistocene zoogeography of *Dicrostonyx* in North America has been discussed at length by Guilday (1963, 1968). Apparently the Ungava lemming, *D. hudsonius*, is a survivor of a formerly widespread Palaearctic *D. henseli-hudsonius* form occurring in a rather isolated tundra zone in eastern North America. Presumably it arrived there during Illinoian time, but its earliest record is from late Wisconsin cave deposits in Pennsylvania. Probably the ice salient in the Great Lakes region during the last glaciation, and Hudson Bay itself during inter-

glacial (Sangamon and present) times helped to maintain the isolation of this relatively primitive group. *D. torquatus* survived the late Wisconsin glaciation in refuges in the unglaciated Yukon-Alaska region and in northwestern United States, where it has been reported from Little Box Elder Cave in Wyoming.

In summary, the evolution of the collared lemming took place rather rapidly during the Pleistocene. The trend was from larger animals with relatively simple molar structure to smaller ones with complicated molar structure (Agadzhanyan 1973, p. 352). The most probable phyletic line is *Predicrostonyx hopkinsi* — *Dicrostonyx simplicior* — *D. henseli-hudsonius* — *D. torquatus*. The major dispersal centre of the group appears to have been Beringia.

Collared lemming fossils are good indicators of tundra conditions in the past, for the species is presently confined to arctic and alpine tundra throughout the Holarctic region from the White Sea in the west to Greenland in the east. In the Yukon there is a northern population *D. t. kilangmiutak* and an isolated grayish form in the Ogilvie Mountains of the central Yukon (Youngman 1975, p. 115).

The collared lemming turns white in winter. Many morphological features including short tail and heavy fur enable it to survive in the relatively severe tundra environment. In winter the third and fourth digits of the foreclaws expand and harden to the point where they are well adapted to digging through wind-packed snow. Temperatures are much warmer under the snow, where they spend most of their time. They are colonial, but perhaps less so than the brown lemmings. Their populations fluctuate dramatically with a periodicity varying between two and five years. In the summer, collared lemmings occupy shallow burrows below the tundra surface, which lead to resting and defecation areas and to nest chambers lined with dry grasses situated above the permafrost. Their winter nests are constructed on the surface of the tundra beneath snowbanks. Summer food consists of sedges, cottongrass, and grasses. In winter they eat willow buds, twigs and bark. Important predators are ermine, arctic fox, wolf, wolverine, owls, hawks, gulls and jaegers, all of which are known from the Pleistocene deposits of the Yukon Territory.

Lemmus sibiricus (brown lemming)

Fossils of brown lemmings (Figures 21A-B, 22A-C)

Figure 21. A. Occlusal view of RM_1-RM_2 in a right mandible (NMC 24899, Old Crow Locality 11A) of a Pleistocene brown lemming *(Lemmus sibiricus)*. SEM photograph.
B. Occlusal view of LM_1-LM_3 in a left mandible (NMC 33757) of a Recent brown lemming *(Lemmus sibiricus)* from northern Canada.

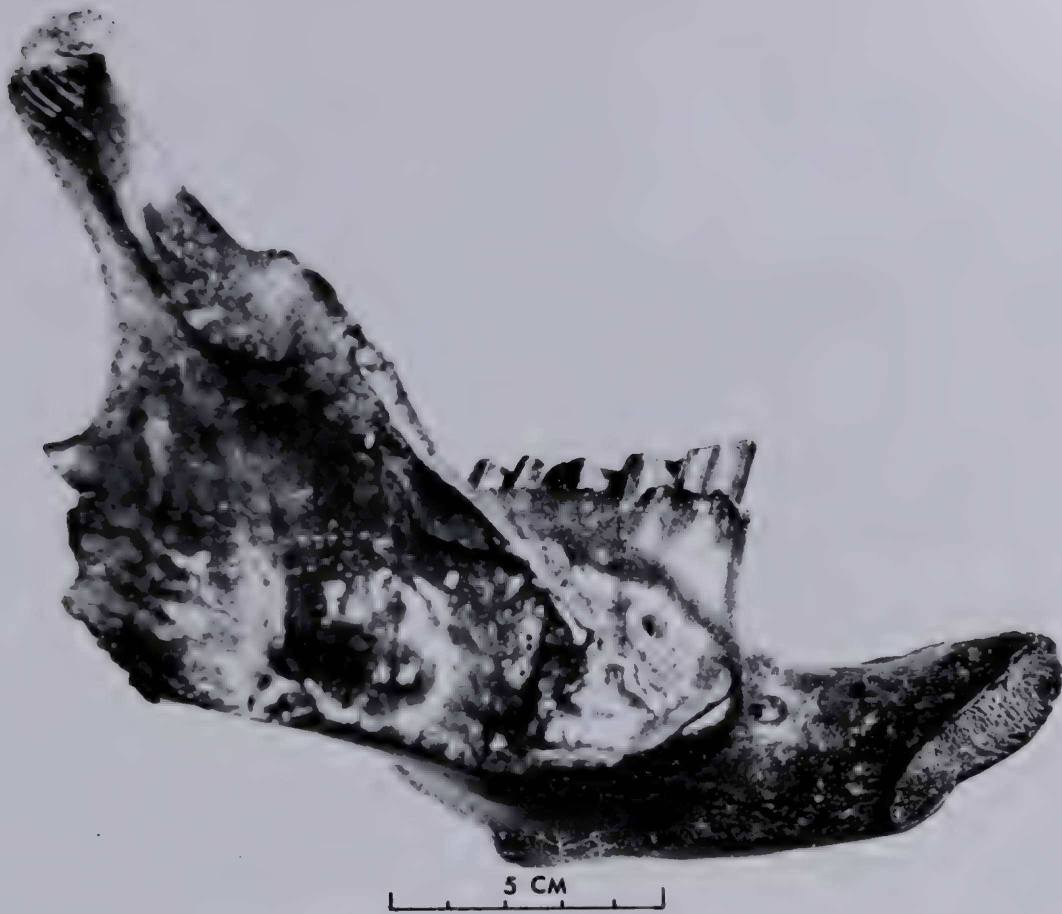
A

3 MM

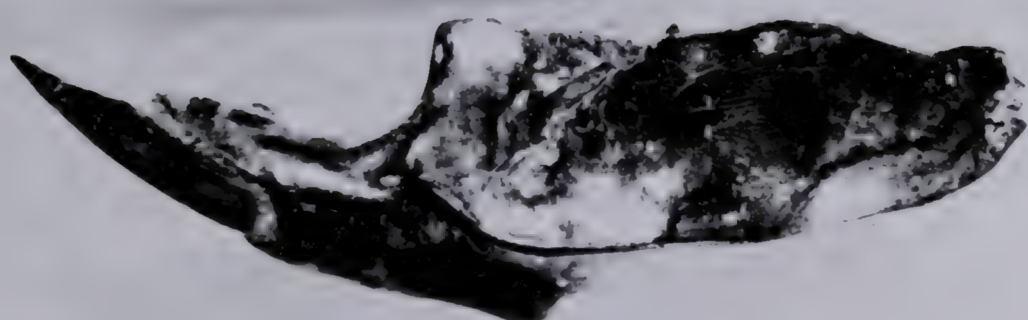
B

3 MM

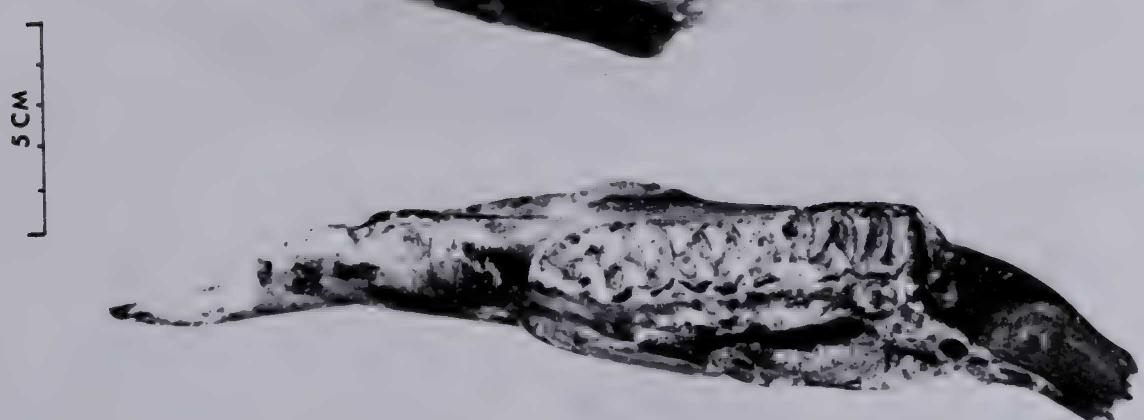
Figure 22. A. Lateral view of a right mandibular fragment with RM_1-RM_2 (NMC 24597, Old Crow Locality 11A) of a Pleistocene brown lemming *(Lemmus sibiricus)*. B. Lateral view of left mandible with all teeth (NMC 28711, Old Crow Locality 27) of a Pleistocene brown lemming *(Lemmus sibiricus)*. C. Occlusal view of NMC 28711.



A



B



C

are more commonly found than those of any other species of rodent in the Old Crow Pleistocene deposits, except muskrats. Apart from some postcranial material not described here, only mandibles have been recovered so far, and few have all teeth. No fossils have been found in the Dawson Area, but teeth have been screened from an organic sandy silt layer with freshwater mollusc shells (*Pisidium idahoense - Cytherissa lacustris* zone) at Porcupine Locality 100, which has been radiocarbon dated at 32,400 ± 770 years B.P. (McAllister and Harington 1969, p. 1188). Most of the specimens are stained dark brown to black. Dental patterns are similar to those of Recent brown lemmings from northern Canada, and all of the Old Crow fossils are referred to *Lemmus sibiricus*.

Referred specimens

NMC 28711 from Old Crow Locality 27 is a left mandible with the incisor and LM_1-LM_3. The following left mandibles have the incisor and LM_1-LM_2: NMC 28717 (Old Crow Locality 27), 28769 (Old Crow Locality 104), 28770 (Old Crow Locality 104), 22096 (Old Crow Locality 27W), 18641 (Old Crow Locality 27), 22087 (Old Crow Locality 27W), 19322 (Old Crow Locality 20), 18574 (Old Crow Locality 29), 18647 (Old Crow Locality 27), 18570 from the sand bar at Old Crow Locality 29; 28772 (Old Crow Locality 104), 19169 (Old Crow Locality 28). The following right mandibles have

the incisor and RM_1-RM_2: NMC 19337 (Old Crow Locality 20), 24548 (Old Crow Locality 11A), 22172 (Old Crow Locality 27W), 22183 (Old Crow Locality 27W), 24409 (Old Crow Locality 11A), 24899 (Old Crow Locality 11A) and 25007 (Old Crow Locality 11A). The following right mandibular fragments have RM_1-RM_2: NMC 24597 (Old Crow Locality 11A), 15839, which was excavated from the fossiliferous zone at Old Crow Locality 44 which may be of Sangamon interglacial age, 18638 (Old Crow Locality 27), 25272 (Old Crow Locality 27W), 25011 (Old Crow Locality 11A), 15634 (Old Crow Locality 28), 25033 (Old Crow Locality 11A), 18899 (Old Crow Locality 20), 18838 (Old Crow Locality 20), 19176 (Old Crow Locality 28), 18417 (Old Crow Locality 11A), and 24544 (Old Crow Locality 11A) which is stained reddish brown. The following left mandibles have LM_1-LM_2: NMC 28774 (Old Crow Locality 104) has heavily worn teeth; 22202 (Old Crow Locality 27W), 15640 (Old Crow Locality 28), 18562 (Old Crow Locality 29), 22100 (Old Crow Locality 27W), 28828 (Old Crow Locality 20).

The following right mandibles have RM_1: NMC 18583 (Old Crow Locality 29), 24676 (Old Crow Locality 22), 19315 (Old Crow Locality 20), 25301 (Old Crow Locality 27W), 18569 (Old Crow Locality 29), 22216 (Old Crow Locality 27W), 25090 (Old Crow Locality 64), which was excavated from an organic layer overlying the basal clay unit that I correlate with

the fossiliferous zone at Old Crow Locality 44, therefore it may be of Sangamon age; 22188 (Old Crow Locality 27W), 18644 (Old Crow Locality 27), 18806 (Old Crow Locality 20), 19335 (Old Crow Locality 20), 18585 (Old Crow Locality 29), 22210 (Old Crow Locality 27W), 25485 (Old Crow Locality 44), which may be of Sangamon interglacial age; 28727 (Old Crow Locality 27). The following left mandibles have the incisor and LM_1: NMC 28776 (Old Crow Locality 104), 22195 (Old Crow Locality 27W), 22076 (Old Crow Locality 27W) which is missing the posterior loop on LM_1; 25494 (Old Crow Locality 44, which is possibly of Sangamon age; 25098 (Old Crow Locality 64), which was excavated from organic sediments overlying the basal clay and, like NMC 25090, may be of Sangamon age; 24814 (Old Crow Locality 20), 25013 (Old Crow Locality 11A), 25089 (Old Crow Locality 64), which was excavated from silt overlying the basal clay and may be of Sangamon age; 25274 (Old Crow Locality 27W). The following left mandibles have LM_1: NMC 19219 (Old Crow Locality 22), 25273 (Old Crow Locality 27W), 25280 (Old Crow Locality 27W), 18584 (Old Crow Locality 29), 22115 (Old Crow Locality 27W), 28833 (Old Crow Locality 20), 22199 (Old Crow Locality 27W), 24815 (Old Crow Locality 20), 19173 (Old Crow Locality 28), 18901 (Old Crow Locality 20), 19164 (Old Crow Locality 28). NMC 28771 from Old Crow Locality 104 is a left mandible with the incisor and LM_2. NMC 24563 from Old Crow Locality 11A is a left

mandible with a damaged LM_2. The following right mandibles have RM_2: NMC 18583 (Old Crow Locality 29), 24676 (Old Crow Locality 22), 28710 (Old Crow Locality 27), 15064 (Old Crow Locality 69), 22134 (Old Crow Locality 27W), 18579 (Old Crow Locality 29), 28715 (Old Crow Locality 27), 18576 (Old Crow Locality 29), 18894 (Old Crow Locality 20), which has a mottled surface; 18641A (Old Crow Locality 27).

Discussion

Mandibles of the brown lemming found *in situ* in organic sediments overlying the basal clay at Old Crow Localities 44 and 64 indicate that *Lemmus sibiricus* may have lived in the Old Crow Basin as early as the Sangamon interglacial. Teeth from mid- Wisconsin organic deposits at Porcupine Locality 100 suggest that brown lemmings lived in wet meadow habitat, with some spruce trees in the vicinity, near the margin of a cool, shallow lake (McAllister and Harington 1969, p. 1189). This species has not been recorded from Pleistocene deposits in other parts of Canada.

The earliest record from Alaska is of *Lemmus* cf. *sibiricus* from the Cape Deceit Formation (?Nebraskan) near Kotzebue Sound (Guthrie and Matthews 1971, p. 492). Teeth have also been screened from organic matrix in deposits considered to be of Illinoian and Wisconsin age near Fairbanks (Guthrie 1969, p. 232; Péwé 1975, p. 96). Although

few brown lemming fossils were collected by Guthrie (1968, p. 231), he notes that more occurred in the middle of zones thought to have been deposited during a full glacial stage. In this regard, the only indications of the presence of brown lemmings in the Old Crow Area are during the ?Sangamon interglacial and mid- Wisconsin interstadial, so possibly they were most abundant during the warmer, wetter phases of the Pleistocene.

I concur with Rausch (1953) and Rausch and Rausch (1975, p. 25) that the Nearctic brown lemming is conspecific with the Ob lemming of Siberia *("Lemmus obensis")*, in which case *Lemmus* cf. *sibiricus* is first recorded in abundance from the northeastern Siberian Olyor deposits of ?Kansan age (Sher 1971, p. 93). *Lemmus sibiricus* is also known from the second terrace deposits on the Aldan River, which seem to be of Illinoian age (Vangengeim 1961); from the Utka Beds of late Illinoian age in the Kolyma Lowland (Sher 1971); from late Pleistocene deposits (Illinoian to Wisconsin?) near the southern tip of Bolshoi Lyakhov Island in the New Siberian Islands (Vangengeim 1961); and from the early Wisconsin Iedoma Suite in the Kolyma Lowland (Sher 1971). Thus, brown lemmings seem to have occupied various parts of northeastern Siberia from at least ?Kansan time to the present.

Another closely related species, the Scandinavian lemming *(Lemmus lemmus)* (Rausch and Rausch 1975, p. 25), a fairly large animal found mostly in alpine birch woods and the zone just above the treeline, occurred in Europe as early as the late Günz (late ?Nebraskan) glaciation (Kurtén 1968, p. 220). As the Cape Deceit record of *Lemmus* may predate this one, perhaps the genus evolved in and radiated from Beringia about the time of the first Quaternary continental glaciation of major proportions in the Northern Hemisphere. The ancestry of *Lemmus* is poorly known, although probably it was derived from the same stock that gave rise to the smaller wood lemming of Eurasia *Myopus schisticolor*. A remarkable fact about the brown lemming is the lack of change in its dental patterns throughout the Pleistocene. Presumably its initial adaptations were quite successful, and it could be argued on this basis that its habits and habitat have changed little since the early Pleistocene.

Brown lemmings prefer moist tundra with abundant grasses and sedges, so their fossils are good indicators of those conditions. The fossils usually indicate proximity to tundra, but the animals themselves are not presently restricted to that type of environment. Brown lemmings occur along the northern coasts from the White Sea to

Baffin Island - a similar distribution to the collared lemming *Dicrostonyx torquatus*, except that the former do not occupy the northern Canadian Arctic Islands, or Greenland, and they extend southward from the Yukon into northern British Columbia. Brown lemmings are found now throughout most of the Yukon Territory except its extreme southwest corner (Youngman 1975, p. 107). The northern Yukon subspecies *Lemmus sibiricus trimucronatus* probably survived the Wisconsin glaciation in the Beringian refugium, while *L. s. helvolus* may have differentiated in a more southerly refugium (Macpherson 1965, p. 169). Rausch and Rausch (1975, p. 27) object to the latter view, stating that the group was derived from the north in postglacial time, but have not provided a good reason for their conclusion.

Brown lemmings have specialized lateral foreclaws for digging. Their coats are chestnut brown on the lower back and buffy gray on the head, shoulders and belly. Their winter coats are longer and grayer. These lemmings are colonial and are active all winter under the snow. Spring and autumn are critical periods for their survival: melting snow in spring exposes their nests and tunnels, and autumn blizzards may catch them before protective snow cover accumulates. Like collared lemmings, they fluctuate

in numbers with a periodicity of 2 to 10 years. They feed mainly on grass shoots and the bases of grass and sedge leaves. They occasionally eat bark and twigs of willows and dwarf birch in winter. Brown lemmings cut hay for winter use, but do not make food caches. They have the same predators as collared lemmings (Banfield 1974, pp. 185-187).

Clethrionomys cf. *rutilus* (northern red-backed vole)

Fossils of this species are rarely found in Pleistocene deposits of the Old Crow Basin. Only six mandibles (Figure 23A-B) have been recovered. None has been found near Dawson. These specimens have dental patterns like Recent northern red-backed voles and are referred to *Clethrionomys* cf. *rutilus* because of their northerly geographic position and because that species occupies the same area during the present interglacial. However, it should be noted that no method is presently available for separating *C. rutilus* from the more southerly *C. gapperi* on the basis of skeletal remains alone. Therefore, comments on the dispersal history of red-backed voles are highly speculative.

Referred specimens

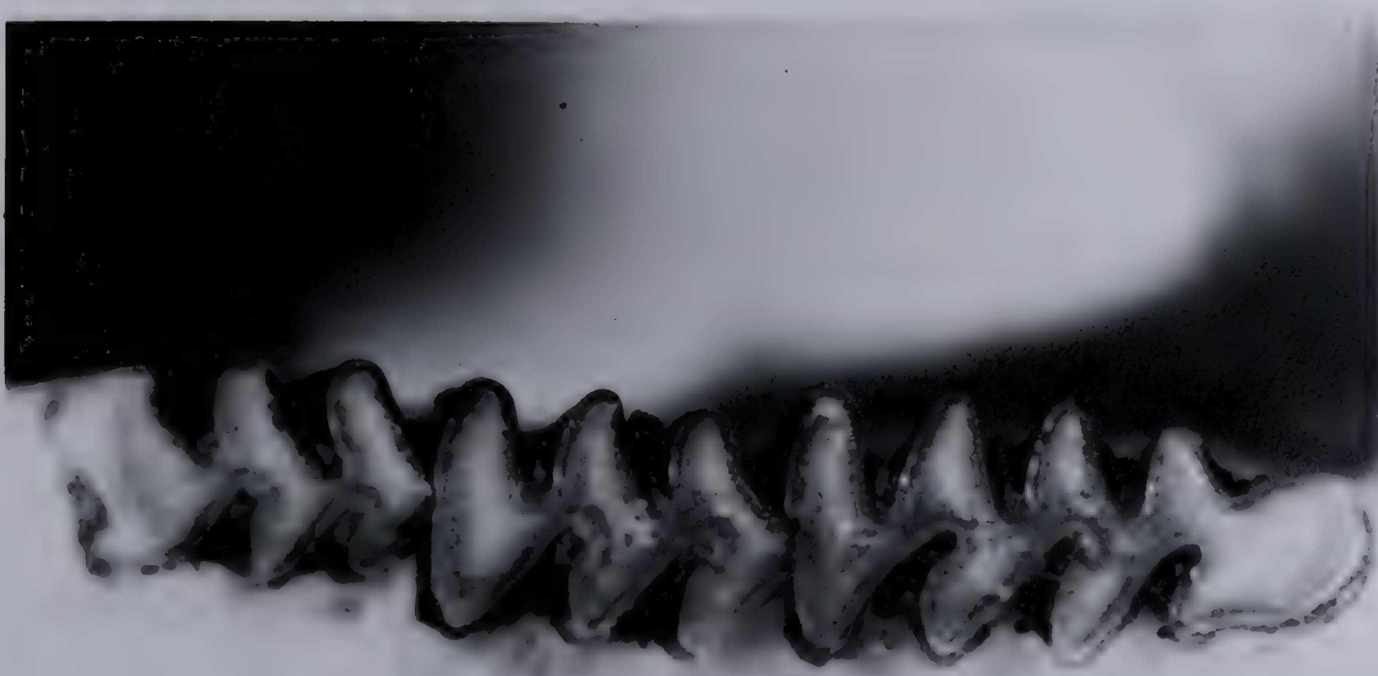
NMC 19323 from Old Crow Locality 20 is a right mandible with the incisor and RM_1-RM_2. It is stained brown

Figure 23. A. Occlusal view of RM_1-RM_2 in a right mandible (NMC 19323, Old Crow Locality 20) of a Pleistocene northern red-backed vole (*Clethrionomys* cf. *rutilus*).

B. Occlusal view of RM_1-RM_3 in a right mandible (NMC 34917) of a Recent northern red-backed vole (*Clethrionomys rutilus*) from northern Canada.

A

3 MM



B

3 MM

and is mottled with yellowish specks. Much of the ascending ramus is preserved. NMC 25496 is a right mandible with RM_1-RM_2. Only the bone surrounding the teeth is preserved. It was excavated from the fossiliferous zone overlying the basal clay at Old Crow Locality 44 and may be of Sangamon interglacial age. NMC 25092 is a badly fragmented left mandible with the incisor and LM_1. It was excavated from sediments overlying the basal clay in a thick bluff section at Old Crow Locality 64, and may be of Sangamon age also. NMC 25497, a left mandible with LM_1, was excavated at Old Crow Locality 44, NMC 25300 from Old Crow Locality 27W is a right mandible with RM_1. NMC 28841 from Old Crow Locality 20 is a left mandible with LM_1.

Discussion

Of the six specimens described, three were derived from deposits of ?Sangamon age, and possibly the others were reworked from those deposits, suggesting that red-backed voles were most common in the Old Crow Basin during late Pleistocene interglacials. But various difficulties arise in presenting ideas of this nature, an important one being that, during glacial maxima, evidently large lakes occurred in the central parts of the basin where most fossil localities are exposed, and the possibility exists that red-backed voles were common on the basin margins at those times. The northern red-backed vole has not been reported previously

from Pleistocene deposits in Canada.

The only other report of the red-backed vole from sedimentary deposits in Eastern Beringia is of *Clethrionomys* sp. from the Tofty fauna, Alaska (Repenning *et al.* 1964). It is difficult to interpret this fauna in paleoenvironmental terms. Fossils from units A and B at Tofty represent a mixture of forest (as indicated by the presence of rooted spruce stumps, beaver-gnawed wood and remains of the red-backed vole) and steppe-tundra forms (the remainder of the fauna). Presumably the steppe-tundra mammals were concentrated from Wisconsin age sediments of unit C, while the moist forest element lived in spruce woodland that existed in the area during postglacial time. If this conjecture is correct, then the red-backed vole remains would be of postglacial age.

An early record of this genus from North America is *Clethrionomys* cf. *gapperi* from deposits of probable Illinoian age at Cumberland Cave, Maryland, where it is part of a relatively minor "northern" faunal component (Guilday 1971, p. 236). Guilday (1971, p. 249) observes that *C. gapperi* and other woodland species increase greatly at the expense of grassland species from bottom to top of stratified sediments in the sinkhole at New Paris No. 4, Pennsylvania. This deposit probably ranges in age from late Wisconsin to postglacial. *C. gapperi* has also been

reported from Wisconsin deposits at Frankstown Cave, Pennsylvania (Hibbard 1958, p. 17), from Robinson Cave, Tennessee and from two other late Pleistocene cave deposits in the Midwest, Mayer Cave, Illinois and Crankshaft Pit, Missouri (Guilday *et al.* 1969, p. 54).

The relationship between *C. rutilus* and *C. gapperi* is not very clear. Rausch and Rausch (1975, p. 169) state that cytogenetic and zoogeographical evidence, including the affinities of the respective species of fleas of *C. rutilus* and *C. gapperi*, are indicative of diverse distributional histories, implying that the latter species survived in the southern refugium and the former occupied the Beringian refugium - the latter spreading northward to meet the former as the Wisconsin ice retreated. Youngman (1975, p. 85) considers *C. rutilus* to be conspecific with *C. gapperi*, but produces no evidence to support his contention.

Clethrionomys is known from early middle Pleistocene (?Kansan) deposits of China (Kurtén 1968, p. 213). In northeastern Siberia fossils of *Clethrionomys* sp. have been collected from the Olyor Suite of ?Kansan age (Sher 1971), while *C. rutilus* has been reported from Illinoian deposits on the second terrace of the Aldan River (Vangengeim 1961).

In Europe, Astian and Villafranchian fossils of this kind have been tentatively referred to the Eurasian bank vole *(Clethrionomys glareolus)*. This medium-sized vole, which prefers open woodlands, is also known from the early middle Pleistocene of Europe. During the late Pleistocene it occurred in many places from England to Poland and the Soviet Union. The species now ranges throughout Europe (excluding Ireland), northernmost Scandinavia, the Mediterranean peninsulas and eastward to Lake Baikal in Asia. Rausch and Rausch (1975, p. 169) state: ..."the relationship between *C. gapperi* and *C. glareolus* would seem to be no closer than that between other species-pairs, such as *C. gapperi* and *C. rutilus*, of which the members also fall into different karyotypic groups."

In summary, *Clethrionomys* seems to have originated in Europe in late Pliocene (Astian) time. The bank vole *C. glareolus* occupied parts of Eurasia throughout the Pleistocene and still lives there. It may have given rise to the North American red-backed voles, including *C. rutilus*, about Illinoian time. Perhaps the northern red-backed vole diverged from its ancestral stock in Beringia. Although the earliest known occurrence of *C. rutilus* in the Nearctic is in ?Sangamon time, obviously *Clethrionomys* had reached North

America during or prior to the early part of the Illinoian glaciation, for remains identified as *Clethrionomys* cf. *gapperi* have been reported from Cumberland Cave, Maryland.

The northern red-backed vole is a relatively small, slender and brightly colored Holarctic species that is distributed from northern Scandinavia through northern Asia, most of Alaska and the northern Canadian mainland to Hudson Bay. It is active all winter and constructs tunnels under the snow. Winter nests are built on the ground surface, while summer nests are in short underground burrows or beneath rocks or large roots. Although the species has been collected at elevations up to 6,000 feet (1830 m) above sea level in habitats varying from dry arctic tundra to floating bogs, it is most common in willow, alder and dwarf birch, or in overgrown talus (Youngman 1975, p. 86). Presumably the fossils from the Old Crow Basin indicate the presence of northern shrub habitat there during the ?Sangamon interglacial. This vole eats leaves, buds, twigs and fruits of shrubs such as those mentioned previously. Corbet (1966) notes that *Clethrionomys* tends to eat more fruit and seeds than other microtines.

Ondatra zibethicus (muskrat)

Hundreds of muskrat fossils have been recovered from Pleistocene deposits in the Old Crow Basin. Except for most of a cranium, only a series of mandibles (Figures 24A-C, 25A-C, Tables 23-24) that contain at least the diagnostic M_1 will be described. Most of these fossils are stained dark brown, but a few are a lighter reddish brown.

In 1966 Semken reported that measurements of fossil muskrat teeth showed an increase in size and an increase in dentine tract height as geological time progressed. These data were reassessed by Nelson and Semken (1970) using more material (particularly Recent specimens), and the results correlated well with those previously obtained by Semken. They (Nelson and Semken 1970, p. 3733) also found that living southern forms have a significantly lower M_1 length to width ratio than living northern forms and suggested that the difference noted in living populations may be applicable to fossil populations, indicating that specimens regarded as of interglacial age would have lower ratios than those considered to be of glacial age. Martin and Tedesco (1974 MS, p.8) generally support the conclusions of Nelson and Semken, but emphasize that

Figure 24. A. Dorsal view of a partial cranium (NMC 28781, Old Crow Locality 101) of a Pleistocene muskrat *(Ondatra zibethicus).* B. Occlusal view of a right mandible (NMC 29403, Old Crow Locality 14N) of a Pleistocene muskrat *(Ondatra zibethicus).* C. Occlusal view of a complete left mandible (NMC 28689, Old Crow Locality 27) of a Pleistocene muskrat *(Ondatra zibethicus).*


28781
3 CM
A
B
C

Figure 25. Compare with Figure 24.

A. Ventral view of NMC 28781.

B. Lateral view of NMC 29403.

C. Lateral view of NMC 28689.


A
3 CM
B
C

Table 23. Measurements of a Pleistocene muskrat *(Ondatra zibethicus)* cranium from the Yukon Territory compared to those of Recent muskrats from the Yukon Territory.

SPECIMENS	SEX	MEASUREMENTS (mm)*			
		1	2	3	4
Ondatra zibethicus. Pleistocene, Y.T.					
NMC 28781 Old Crow Loc. 101	-	38.3	13.2	6.3	14.2
Ondatra zibethicus. Recent, Old Crow, Y.T. (Youngman 1975, p. 105)					
M	4♂ 2♀	37.6	12.9	5.9	14.3
OR		37.2 - 38.7	12.6 - 13.1	5.5 - 6.2	13.4 - 14.1
N		6	6	6	6
SD		0.43	0.19	0.29	0.53
SE		0.22	0.07	0.12	0.22
Ondatra zibethicus. Recent. Southern Yukon (Youngman 1975, p. 105)					
M	14♂ 3♀	39.5	13.6	5.9	15.1
OR		38.3 - 40.9	12.5 - 14.7	4.4 - 6.5	14.4 - 15.8
N		17	17	17	17
SD		1.28	0.65	0.47	0.43
SE		0.31	0.16	0.11	0.10

* 1. Zygomatic breadth. 2. Rostral breadth. 3. Least interorbital width. 4. Alveolar length of maxillary tooth row.

Table 24. Measurements of Pleistocene muskrat (*Ondatra zibethicus*) mandibles from the Yukon Territory compared to those of Recent muskrats from the Yukon Territory.

SPECIMENS	SEX	MEASUREMENTS (mm)*				
		1	2	3	4	5
Ondatra zibethicus, Pleistocene, Old Crow, Y.T.						
NMC 15319 Loc. 22	-	6.3	2.6	12.9	11.7	7.5
NMC 16873 Loc. 14N	-	6.6	2.6	14.2	10.9	8.9
NMC 29403 Loc. 14N	-	6.9	2.7	14.0	11.3	9.4
NMC 27233 Loc. 29	-	7.1	2.8	14.6	10.2	8.5
NMC 18634 Loc. 27	-	6.6	2.5	13.4	10.6	8.6
NMC 19198 Loc. 22	-	6.7	2.8	13.9	11.6	8.5
NMC 24614 Loc. 22	-	6.7	2.8	13.9	10.5	8.9
NMC 24365 Loc. 11A	-	6.5	2.7	13.5	-	-
NMC 25054 Loc. 22	-	6.2	2.4	12.1	-	-
NMC 24648 Loc. 67	-	6.3	2.5	13.6	-	8.8
NMC 18797 Loc. 20	-	6.0	2.7	13.0	-	-
NMC 28624 Loc. 65	-	6.7	2.8	13.7	-	10.7
NMC 24666 Loc. 22	-	6.4	2.6	13.6	-	9.2
NMC 16879 Loc. 14N	-	6.2	2.6	13.0	-	8.5
NMC 24367 Loc. 11A	-	6.2	2.5	13.2	-	8.4
NMC 25052 Loc. 22	-	6.9	2.5	13.6	-	-
NMC 28703 Loc. 27	-	6.4	2.6	13.5	-	-
NMC 15712 Loc. 28	-	5.9	2.3	12.6	-	8.4
NMC 18508 Loc. 29	-	6.8	2.8	-	13.2	9.3
NMC 15824 Loc. 44	-	6.1	2.6	-	-	-
NMC 15822 Loc. 44	-	6.6	2.6	-	-	5.6
NMC 15821 Loc. 44	-	6.5	2.5	-	10.7	7.4
NMC 24357 Loc. 11A	-	6.7	2.7	-	12.9	9.9
NMC 24359 Loc. 11A	-	6.7	2.8	-	9.8	8.5
NMC 15818 Loc. 44	-	6.6	2.6	-	-	7.9
NMC 15817 Loc. 44	-	6.1	2.5	-	9.6	-
NMC 28669 Loc. 27	-	6.1	2.4	-	-	7.9
NMC 26996 Loc. 28	-	6.2	2.5	-	11.0	-
NMC 26668 Loc. 15	-	6.3	2.6	-	-	7.2
NMC 28860 Loc. 66	-	6.9	2.8	-	-	9.3
NMC 24452 Loc. 11A	-	6.6	2.4	-	-	-
NMC 15710 Loc. 28	-	6.5	2.6	-	-	-
NMC 18739 Loc. 20	-	6.3	2.4	-	-	-
NMC 27043 Loc. 32E	-	6.9	2.7	-	-	-
NMC 22263 Loc. 27W	-	6.2	2.5	-	10.9	-
NMC 14903 Loc. 31	-	6.3	2.5	-	-	7.9
NMC 19242 Loc. 44	-	6.4	2.6	-	-	-
NMC 28701 Loc. 27	-	6.7	2.4	-	-	-
NMC 28689 Loc. 27	-	6.9	2.8	14.1	12.1	9.7
NMC 22251 Loc. 27W	-	6.7	2.7	-	-	9.4
NMC 15820 Loc. 44	-	6.8	2.7	-	-	9.1
NMC 15249 Loc. 22	-	7.1	3.0	-	-	9.8
NMC 24807 Loc. 20	-	7.0	2.8	-	-	9.0
NMC 22051 Loc. 27	-	6.4	2.6	-	-	8.8
NMC 19197 Loc. 22	-	7.1	2.8	-	-	9.7
NMC 24859 Loc. 11A	-	6.6	2.5	-	-	9.4
NMC 15567 Loc. 20	-	6.1	2.4	-	-	-
NMC 25312 Loc. 27W	-	6.6	2.6	-	-	-
NMC 22260 Loc. 27W	-	6.7	2.6	-	-	-
NMC 25051 Loc. 22	-	6.2	2.4	-	-	7.9
NMC 28636 Loc. 65	-	6.6	2.6	-	-	-
NMC 15827 Loc. 44	-	6.0	2.4	-	-	-
NMC 19195 Loc. 28	-	6.4	2.3	-	-	-
NMC 22045 Loc. 27W	-	6.9	2.9	-	-	-
NMC 15636 Loc. 28	-	6.1	2.3	-	-	-
NMC 22050 Loc. 27W	-	6.4	2.5	-	8.5	-
NMC 28600 Loc. 103	-	6.4	2.7	-	-	-
NMC 25050 Loc. 22	-	6.3	2.7	-	-	-
NMC 15828 Loc. 44	-	6.1	2.6	-	-	-
NMC 15823 Loc. 44	-	6.2	2.4	-	-	-
NMC 22164 Loc. 27W	-	6.8	2.5	-	-	-
NMC 22261 Loc. 27W	-	6.1	2.5	-	-	-
NMC 20750 Loc. 20	-	6.3	2.8	-	-	-
Ondatra zibethicus, Recent, Y.T.						
NMC 2229	♀	6.6	2.6	14.2	10.5	8.8
NMC 2226	♂	7.3	3.1	14.0	12.5	10.2
NMC 2228	♂	6.7	2.6	14.7	11.4	9.3
NMC 2225	♂	6.6	2.7	13.6	11.3	10.1
NMC 2230	♀	7.2	3.0	13.8	13.3	10.8
NMC 2227	♂	6.7	2.9	14.1	11.2	8.7
NMC 29897	♀	6.7	2.9	14.0	11.4	9.1
NMC 29898	♂	7.1	2.9	14.2	11.8	9.0
NMC 29899	♂	7.0	2.9	14.1	12.2	9.5
NMC 29900	♀	6.6	2.6	13.8	11.5	9.2
NMC 31501	♀	7.0	2.7	14.5	11.8	9.0
NMC 31502	♂	7.4	2.9	14.0	13.3	9.3

* 1. M_1 length. 2. M_1 width. 3. Alveolar length M_1-M_3. 4. Diastema length anterior alveolar margin of M_1 to posterior alveolar margin of I_1. 5. Mandible depth below centre of M_1 (lingual side).

specimens must be of Sangamon (possibly Illinoian?) age or younger, which makes the ability to distinguish glacial and interglacial fossils of limited value.

A preliminary study of a smaller sample than that provided here of Pleistocene muskrat mandibles from the Old Crow Basin was undertaken by Marla L. Weston (1975 MS). Her evidence tended to support the hypothesis that the ratio of increase of tooth width relative to length decreases with time. She also notes that: (a) where western Canadian Recent muskrats are concerned, statistical analysis of M_1 length/width ratios with respect to latitude only provides significant results if means rather than individual values are used; (b) living southern forms show significantly larger alveolar length and mandible depth means than northern ones, indicating that there is a trend toward increasing size from north to south (Youngman 1975, p. 106 also mentions the possibility of a north - south cline existing in the Yukon); (c) Semken's (1966) proposal that lingual dentine tract height on M_1 increases with time is not acceptable on the basis of the data she (Weston) sampled (therefore it is not measured here); (d) generally, muskrat fossils are useful in solving biostratigraphic problems only if large numbers are available so that means can be compared. In the last respect, the Old Crow sample

seems adequate, but relatively few specimens were found *in situ*. Also the effect on the sample of possible north - south clines operating in the past is difficult to estimate. But, as little geochronological control is available for the Old Crow fossils, their M_1 dimensions were plotted on Nelson and Semken's chronocline in the hope of obtaining a very approximate indication of their geological age.

Except for their generally smaller size, the Old Crow Pleistocene bones are very similar to those of Recent muskrats, and until the opportunity arises to carry out detailed comparisons with *Ondatra nebracensis*, which has been recorded from the early Illinoian of Kansas (Hibbard 1970, p. 423), they are referred to *Ondatra zibethicus*.

Referred specimens

NMC 28781 from Old Crow Locality 101 is a cranium lacking the posterior part, the nasals and all teeth except M^3s. It is stained dark reddish brown. The following right mandibles have all teeth: NMC 15319 (Old Crow Locality 22), 16873 and 29403 (Old Crow Locality 14N), 27233 (Old Crow Locality 29), 18634 (Old Crow Locality 27). The following left mandibles have all teeth: NMC 28689 (Locality 27), 19198 (Old Crow Locality 22), which has unusually whitish teeth relative to the brown staining of the mandibular bone, 24614 (Old Crow Locality 22), 24648 (Old Crow

Locality 67), 18797 (Old Crow Locality 20), which is mottled with yellowish specks. The following right mandibles have RM_1-RM_3: NMC 28624 (Old Crow Locality 65), 24666 (Old Crow Locality 22), 16979 (Old Crow Locality 14N), 15824, 15822 and 15821, which were excavated from the fossiliferous zone overlying the basal clay unit at Old Crow Locality 44 and may be of Sangamon interglacial age, 24357 (Old Crow Locality 11A), which has ivory colored teeth while the mandibular bone is reddish brown, 15818 and 15817, which were excavated from organic deposits overlying the basal clay unit at Old Crow Locality 44 and may be of Sangamon age, 28669 (Old Crow Locality 27).

The following right mandibles have RM_1-RM_2: NMC 26668 (Old Crow Locality 15), 28860 (Old Crow Locality 66), 24452 (Old Crow Locality 11A), 18739 (Old Crow Locality 20), 27043 (Old Crow Locality 32E), 22263 (Old Crow Locality 27W), 14903 (Old Crow Locality 31), 19242, which was excavated from fossiliferous sediments overlying the basal clay unit at Old Crow Locality 44 and may be of Sangamon interglacial age; 28701 (Old Crow Locality 27), which has an abnormally bevelled, highly polished anterior loop on RM_1. The following left mandibles have LM_1-LM_2: NMC 22251 (Old Crow Locality 27W), 15820, which was excavated from Old Crow Locality 44 and may be of Sangamon age, 15249 (Old Crow Locality 22), 24807 (Old Crow Locality 20), 22051 (Old Crow Locality 27),

19197 (Old Crow Locality 22), 24859 (Old Crow Locality 11A), 15567 (Old Crow Locality 20), 25312 and 22260 (Old Crow Locality 27W), 25051 (Old Crow Locality 22), 28636 (Old Crow Locality 65), 15827, which was excavated from organic sediments overlying the basal clay unit at Old Crow Locality 44 and may be of Sangamon age, 19195 (Old Crow Locality 28), 22045 (Old Crow Locality 27W), 15636 (Old Crow Locality 28). NMC 22050 from Old Crow Locality 27W is a left mandible with the incisor and LM_1.

The following left mandibles have LM_1: NMC 28600 (Old Crow Locality 103), 25050 (Old Crow Locality 22), 15828, which was excavated from Old Crow Locality 44 and may be of Sangamon interglacial age. The following specimens are right mandibles with RM_1: NMC 15823, which was excavated from the fossiliferous zone overlying the basal clay unit at Old Crow Locality 44 and may be of Sangamon interglacial age, 22164 and 22261 (Old Crow Locality 27W), 20750 (Old Crow Locality 20).

Discussion

Several fossils from Locality 44 indicate that muskrats occupied the Old Crow Basin as early as the ?Sangamon interglacial. The relatively small sizes of the M_1s in the Yukon fossils places them within the zone of Illinoian specimens in Nelson and Semken's (1970, p. 3734,

Figure 1) scattergram of M_1 length versus width in fossil and Recent *Ondatra*. Accounting for a possible cline of decreasing size from south to north, it is reasonable that the Yukon fossils could be interpreted as being of Sangamon interglacial age (Nelson and Semken 1970, Figure 5). The only other Quaternary records of *Ondatra zibethicus* in Canada are from Sangamon interglacial deposits at Medicine Hat, Alberta (Stalker and Churcher 1970) and from post-glacial beds near Hamilton, Ontario (Wetmore 1958).

A nearly complete specimen from bedded sand and silt abutting on an end moraine of Illinoian age near Kotzebue is the earliest record of the muskrat *O. zibethicus* from Alaska (Péwé and Hopkins 1967, p. 268). It may be of late Illinoian or possibly Sangamon age.

The North American ancestry of the muskrat (*Ondatra* sp.) is clear. The probable phyletic line leads from an early member of the *Ogmodontomys* stock to *Pliopotamys minor*, *Pliopotamys meadensis*, *Ondatra idahoensis* (or *Pliopotamys idahoensis* according to Shotwell 1970, p. 68), *Ondatra annectens*, *Ondatra nebracensis*, and finally to the living *Ondatra zibethicus*. Similarity of palatal and dental characters suggests that *Pliopotamys* could have been derived from a primitive *Ogmodontomys* during the late

Pliocene (Zakrzewski 1969, p. 27). Hibbard and Zakrzewski (1967) considered *Pliopotamys* as ancestral to *Ondatra*, and Zakrzewski's (1969, p. 27) later findings tended to support that hypothesis. Zakrzewski noticed that by plotting *Pliopotamys* M_1 lengths against widths that Semken's size cline for *Ondatra* could be carried back in time through the former genus (Nelson and Semken 1970, p. 3734, Figure 1). *Pliopotomys* occurred in the late Pliocene of Idaho and the early Pleistocene of Kansas and Nebraska. Cement in the reentrant angles of the teeth may have been acquired during the transition from *Pliopotamys meadensis* to *Ondatra idahoensis* according to Chaline (1975, p. 35). Muskrat remains are abundant and widespread in late Kansan and post- Kansan deposits of North America. In the Great Plains of the United States, *Ondatra annectens* was dominant during Kansan time, giving way to *O. nebracensis* in the early Illinoian (Hibbard 1970). *Ondatra zibethicus* first appears widely in the Sangamon interglacial, and it is during this phase that the species probably reached Eastern Beringia. Evidently muskrats flourished in the Old Crow Basin during the ?Sangamon interglacial, according to the number of fossils recovered, and the situation appears to be similar during the present interglacial, for the Old Crow Basin is among the foremost sources in the world for commercial muskrat pelts.

The muskrat occurs throughout most of North America with the exception of parts of the arid southwest and most of the arctic tundra. It is a large rodent weighing approximately 3 pounds (1.3 kg) and measuring about 2 feet (0.6 m) long. It is well adapted to aquatic life with partially webbed feet and waterproof fur. Its greatest value as a paleoenvironmental indicator is to suggest the presence of large areas of permanent water. Muskrats prefer lakes, rivers, ponds and marshes where the water is between 4 and 12 feet (1.2 and 2.7 m) deep, so that it will not freeze to the bottom, yet will allow growth of submerged vegetation. Indeed, muskrats spend most of their time in the water, where they use their hind feet as propellers and their tails as rudders. They commonly build houses of marsh plants and also use bank dens if there is any firm ground around their ponds. In winter they pull up submerged vegetation through the ice, creating "push-ups", or domes of frozen vegetation that protect their plunge-holes. In summer muskrats feed mainly on emergent plants such as cattail, bulrush, sedges, and waterlilies. Mink and men are among its most serious predators. On land muskrats are attacked by foxes, coyotes, wolves and birds of prey.

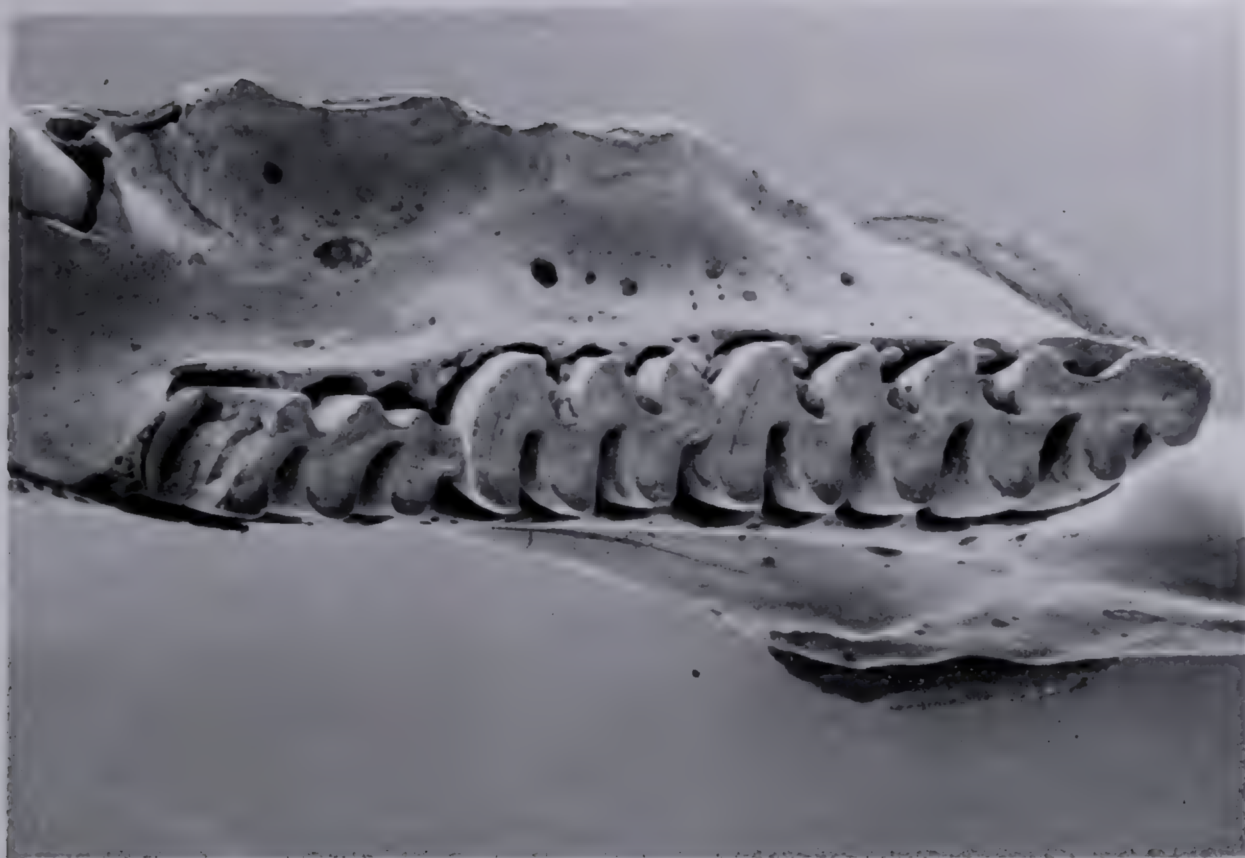
Microtus (Stenocranius) miurus (singing vole)

Mandibles of singing voles are less commonly found than those of chestnut-cheeked voles *(Microtus xanthognathus)* in the Pleistocene deposits of the Old Crow Basin. Fifteen mandibles (Figure 26A-B) are described that have tooth patterns most closely matching those of Recent singing voles. The specimens are stained dark brown to black.

Referred specimens

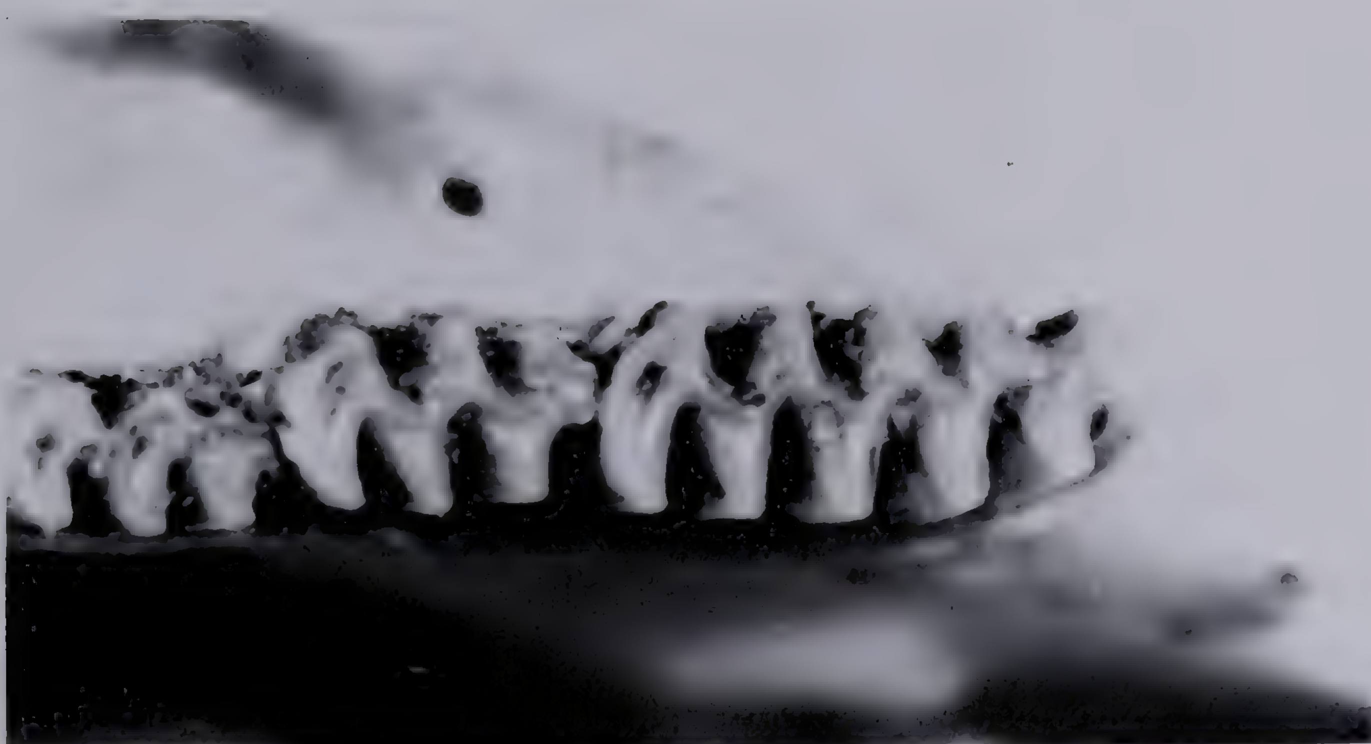
NMC 24566 is a left mandible with the incisor and LM_1-LM_3. It was collected at Old Crow Locality 11A. The following left mandibles have the incisor and LM_1-LM_2: NMC 22180 (Old Crow Locality 27W), 25091 and 25117 which were excavated from the organic silt zone overlying the basal clay unit at Old Crow Locality 64 and which may be of Sangamon interglacial age. The following are right mandibles with the incisor and RM_1-RM_2: NMC 15003 (Old Crow Locality 69), 22170, 22201 and 22079 (Old Crow Locality 27W), and 25096, which was excavated from organic silts overlying the basal clay at Old Crow Locality 64 and may be of Sangamon age. NMC 25292 from Old Crow Locality 27W is a right mandible with RM_1-RM_2, as is NMC 18640 from Old Crow Locality 27. The anterior loop of RM_1 is open in the latter specimen - a variation from the usual condition as shown in Banfield

Figure 26. A. Occlusal view of a left mandible showing LM_1-LM_3 (NMC 24566, Old Crow Locality 11A) of a Pleistocene singing vole *(Microtus (Stenocranius) miurus)*. SEM photograph. B. Occlusal view of a left mandible showing LM_1-LM_3 (NMC 30458) of a Recent singing vole *(Microtus (Stenocranius) miurus)* from northern Canada.



3 MM

A



B

3 MM

(1974, p. 182). The following left mandibles have LM_1-LM_2: NMC 22081 (Old Crow Locality 27W), 25122 and 25094 (Old Crow Locality 64), which were excavated from organic silt overlying the basal clay unit and may be of Sangamon age. NMC 25288 from Old Crow Locality 27W is a right mandible with RM_1.

Discussion

The fossils from Locality 64 indicate the presence of singing voles in the Old Crow Basin as early as the ?Sangamon interglacial. The only other Pleistocene *Microtus* records from Canada are: *Microtus* sp. from deposits considered to be of Sangamon interglacial and mid-Wisconsin interstadial ages at Medicine Hat, Alberta (Stalker and Churcher 1970); *Microtus pennsylvanicus* from postglacial deposits at Scarborough Bluffs, Toronto, Ontario (Churcher and Karrow 1963); and *M. pennsylvanicus* and *M. pinetorum* from postglacial deposits near Hamilton, Ontario (Wetmore 1958).

The earliest record of *Microtus* in Eastern Beringia is from Alaska, where *M. deceitensis* specimens have been excavated from the Cape Deceit Formation (?Nebraskan). *M. deceitensis* has characteristics that are more primitive than *paroperarius* of the late Kansan Cudahy fauna. *Microtus* sp. has also been reported from the Inmachuk (?Kansan) and Deering (?Illinoian to postglacial) Formations at Cape

Deceit (Guthrie and Matthews 1971). Near Fairbanks in central Alaska, *M. miurus* is the most commonly found small mammal fossil, and it covers the greatest stratigraphic range from Illinoian to late Wisconsin time (Guthrie 1968a, p. 231). It has also been reported from deposits of probably Wisconsin age at Tofty, Alaska, where it was more numerous than all other rodents recovered (Repenning *et al.* 1964, p. 196).

The earliest Eurasian record of *Microtus* is from late Günz (late ?Nebraskan) deposits (Kurtén 1968, p. 217). By the middle Pleistocene, *Microtus* became abundant and widespread in Europe. It is interesting to note that *M. (Stenocranius) gregalis*, the gregarious vole of Eurasia, is the closest relative of *M. miurus* (it was considered to be conspecific with the singing vole until Fedyk (1970) showed that *M. gregalis major* from Siberia had a diploid number of 54 chromosomes compared to 72 for *M. miurus* (Rausch 1964)), and first occurs during the Mindel (?Kansan) glaciation of Europe. Evidently it was most common there during glacial phases. Würm (Wisconsin) records are known from England, Germany, Switzerland, Czechoslovakia, Hungary and Poland (Kurtén 1968, p. 219).

The earliest *Microtus* record from northeastern

Siberia is *M.* cf. *(Stenocranius) gregalis*, from sediments of the Olyor Suite (?Kansan) (Sher 1971). *M. gregalis* has also been reported from the second terrace deposits (Illinoian) of the Aldan River (Vangengeim 1961). *M. (Stenocranius)* sp. is present in the mammalian fauna from the Iedoma Suite of early Wisconsin age in the Kolyma Lowland (Sher 1971).

Mimomys newtoni and *Allophaiomys pliocaenicus*, voles of the Villafranchian and early middle Pleistocene of Europe, appear to be the immediate ancestors of *Microtus* (Chaline 1974, p. 441). *Microtus* seems to have evolved by Nebraskan time and *M. deceitensis* is the earliest record, suggesting a Beringian dispersal centre for the genus (Guthrie and Matthews 1971, p. 499). *M. paroperarius*, which was likely derived from *M. deceitensis*, had reached the southern part of North America by late Kansan time. *M. (Stenocranius) gregalis* first appears in Eurasia during the Mindel (?Kansan) glaciation and survives there to the present day, where, like the singing vole, it prefers well-drained habitat. Voles of this narrow-skulled stock had reached Alaska by Illinoian time, the species *M. (Stenocranius) miurus* having evolved in Eastern Beringia. Two subspecies, *M. m. muriei* and *M. m. cantator*, are found in the northern and southern parts of the Yukon Territory,

respectively (Youngman 1975, p. 102).

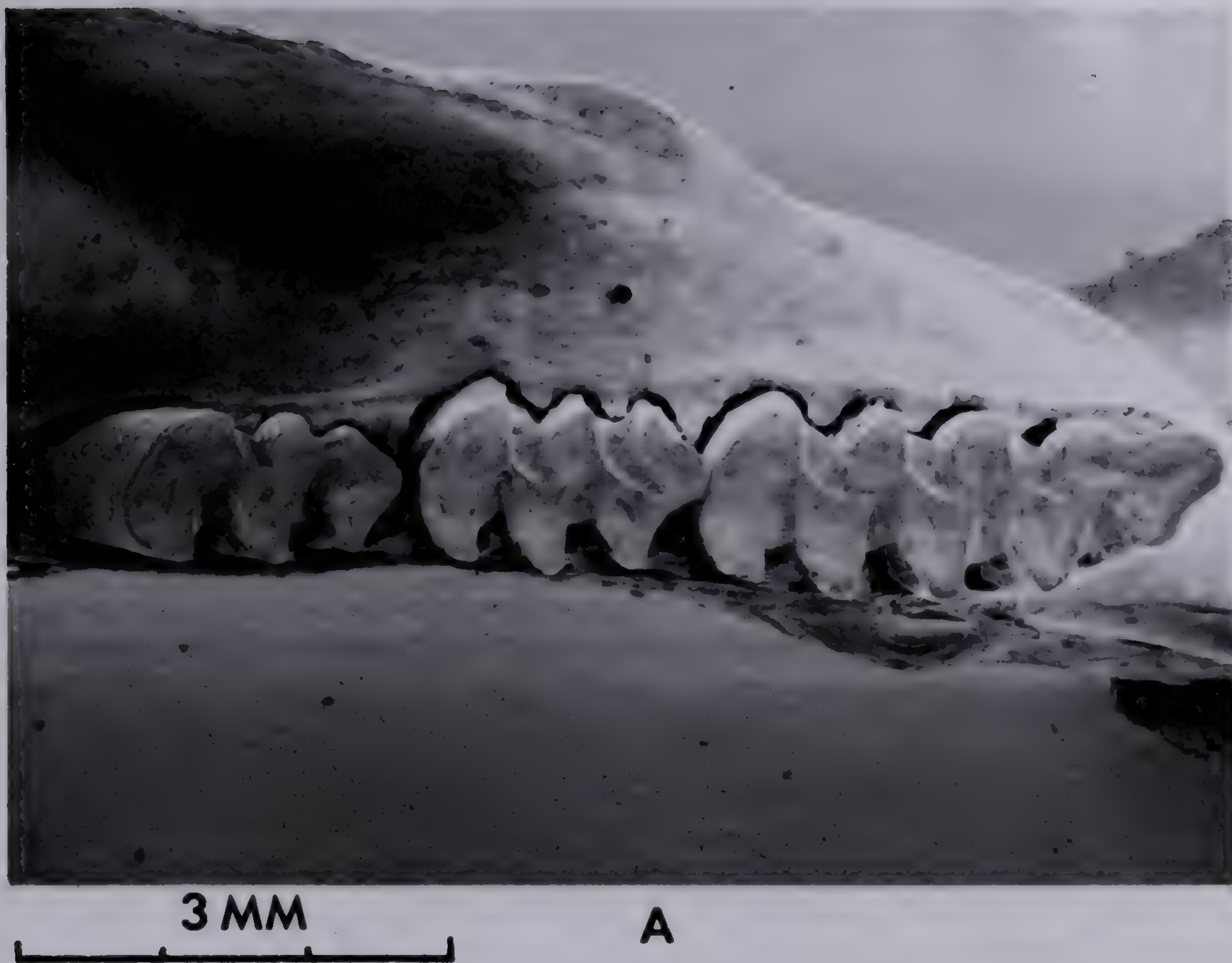
The singing vole is of medium size and is found throughout most of Alaska (excepting the central part) and the Yukon Territory and the westernmost mainland of the Northwest Territories. It is tawny gray to grayish brown and lives in colonies. It prefers dry alpine tundra, and the fossils probably indicate this type of paleoenvironmental niche. Singing voles dig short, shallow burrows that lead to relatively large nesting and storage areas. They feed on forbs, such as lupine, arctic locoweed, horsetails, and leaves and twigs of arctic willow. In autumn they cache large amounts of food for winter use and cut stacks of willow leaves and green forbs, which are left as outside supplies. Their predators include Gray Jays, jaegers, owls, weasels, wolves and foxes.

Microtus xanthognathus (chestnut-cheeked vole)

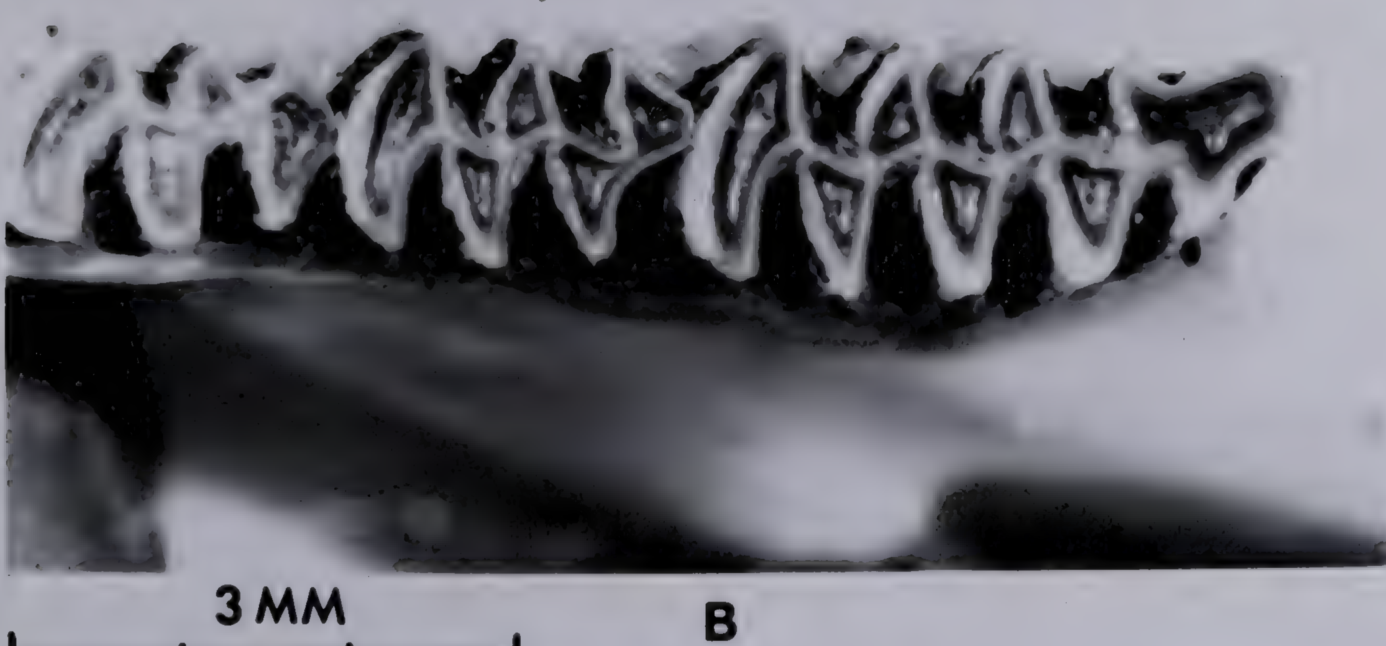
Twenty mandibles (Figure 27A-B) are described from Pleistocene deposits of the Old Crow Basin. The mandibles are generally larger than those of the singing vole *(Microtus (Stenocranius) miurus)* fossils from the same region and their dental patterns compare most closely with those of Recent chestnut-cheeked voles. Most of the specimens are stained dark brown to black.

Figure 27. A. Occlusal view of a left mandible showing LM_1-LM_3 (NMC 18839, Old Crow Locality 20) of a Pleistocene chestnut-cheeked vole *(Microtus xanthognathus)*. SEM photograph.

B. Occlusal view of a left mandible showing LM_1-LM_3 (NMC 35087) of a Recent chestnut-cheeked vole *(Microtus xanthognathus)* from northern Canada.



A



B

Referred specimens

NMC 18839 from Old Crow Locality 20 is a left mandible with all teeth. The following left mandibles have the incisor and LM_1-LM_2: NMC 22211, 22107, 22277 (Old Crow Locality 27W), 18870, 19339 (Old Crow Locality 20), 24415 (Old Crow Locality 11A), 18645 (Old Crow Locality 27). The following right mandibles have the incisor and RM_1-RM_2: NMC 22222 (Old Crow Locality 27W), 18840 and 19332 (Old Crow Locality 20). The following right mandibles have RM_1-RM_2: NMC 25119 was excavated from organic silt overlying the basal clay unit in the high bluff exposure at Old Crow Locality 64, indicating that it may be of Sangamon interglacial age; 22080 (Old Crow Locality 27W), 19175 and 19178 (Old Crow Locality 28). The following left mandibles have LM_1-LM_2: NMC 25116 was excavated from organic silt overlying the basal clay unit at Old Crow Locality 64 and may be of Sangamon age; 22109 and 22203 (Old Crow Locality 27W), 28773 and 28775 (Old Crow Locality 104).

Discussion

The fossils excavated from Locality 64 indicate that chestnut-cheeked voles occupied the Old Crow Basin during the ?Sangamon interglacial. Evidently they were contemporaneous with the singing voles, which probably lived in drier more open habitat. Other *Microtus* fossils from Canada are reviewed in the section on *M. miurus*.

There are three late Pleistocene to postglacial records of the chestnut-cheeked vole from Alaska. The most remarkable of these is a mummified specimen from permafrost at Chicken Creek near the Canada-Alaska border (Guilday and Bender 1960; Youngman 1975, p. 98). I suspect that this specimen is of Wisconsin age, for Péwé (1975b) notes that the best preserved carcasses of Pleistocene mammals in the Fairbanks area have been derived from the Goldstream Formation, which he considers to be of Wisconsin age. In addition, radiocarbon analyses of bison and horse bone from Lost Chicken Creek, which is near the *M. xanthognathus* locality, have yielded dates of 26,760 ± 300 years B.P. (SI-355) and 10,370 ± 160 years B.P. (I-8582), respectively (Harington 1976 MS, p. 78). A single molar was collected from deposits of possible postglacial age at Ready Boullion Bench near Fairbanks (Guthrie 1968a, p. 232). Another single molar from the Tofty area probably is referable to *M. xanthognathus*. It was derived from unit B, which evidently contains a mixture of specimens of Wisconsin and postglacial age (Repenning *et al.* 1964, p. 196).

M. xanthognathus has been recorded from 11 Pleistocene localities in the eastern United States (Hallberg *et al.* 1974, p. 641). Most of these localities are in the states of Pennsylvania, Virginia, West Virginia, Kentucky,

Illinois, Missouri, Arkansas, and Iowa. Radiocarbon dates on associated material from two sites suggest that the specimens are of late Wisconsin age. The authors mentioned put forward a cogent argument that chestnut-cheeked vole fossils from these localities are indicative of a type of parkland with no modern analog, but with affinities to the southern boreal forest. It is interesting to note that this apparent parkland region was one in which extinct musk-oxen (*Symbos cavifrons* and *Boötherium sargenti*) were most heavily concentrated in the southern refugium.

The origins of the chestnut-cheeked vole are not very clear. Chaline (1974, p. 448-449) considers that *M. xanthognathus*, *M. chrotorrhinus* and *M. pennsylvanicus* belong to a North American group that is part of the subgenus *Arvalomys*, and that was derived from a European *M. agrestis*-like stock toward the end of the Kansan glaciation. He indicates that the meadow vole *M. pennsylvanicus* diverged from the ancestral line leading to *M. xanthognathus* and the rock vole *M. chrotorrhinus* about Illinoian time. The latter two species, he suggests, differentiated from a common ancestor near the close of the Wisconsin glaciation, which is difficult to understand in view of the fact that (a) *M. xanthognathus* has been recorded from ?Sangamon (<54,000 years B.P.) deposits in the Yukon; (b) clearly

identifiable specimens of *M. xanthognathus* and *M. chrotorrhinus* were associated in cave deposits at New Paris No. 4, Pennsylvania that are approximately 11,300 years old (Guilday *et al.* 1964, p. 135; (c) *M. xanthognathus* and *M. chrotorrhinus* differ considerably cytogenetically, morphologically, ecologically and ethologically (Youngman 1975, p. 98).

It is difficult to explain the present distribution pattern of *M. xanthognathus* - particularly as no subspecies have been identified. Youngman (1975, p. 99) suggests that the species had a southern origin and closely followed the retreating glaciers northward. That is possible if he means that it had a southern origin before the Wisconsin glaciation. The possibility that one or two of the Alaskan Pleistocene fossils are of Wisconsin age also casts doubt on this rather straightforward analysis involving a northwestern movement toward Beringia from the southern refugium as the Wisconsin ice retreated.

The chestnut-cheeked vole is a large microtine found only in North America from the northern prairie provinces of Canada to central Alaska. It is dark brown above and has a grayish belly. The prominent rusty yellow patch on the nose is characteristic. This species lives mainly

in boreal forest regions, but also occurs in sphagnum bogs. It is colonial and digs deep burrows in the crumbly forest earth. Chestnut-cheeked voles sometimes make nests of dried sedges, and feed on horsetails, willows, lichens, mosses, mushrooms and berries.

Order Cetacea

Family indeterminate

Genus and species indeterminate (large whale)

Referred specimen

In the summer of 1970 M. Bouchard, an assistant of V. Rampton then of the Geological Survey of Canada, collected at Herschel Island Locality 2 a heavily permineralized fragment (NMC 17611) of what appears to be whale bone according to its cellular structure. Its maximum dimensions are approximately 360 mm long x 70 mm across x 7 mm deep. The bone was *in situ* in what Bouchard considered to be "preglacial marine sands" with a few bands of organic-rich silt. Peaty material and at least two water-rounded stones fill a canal 15 mm in diameter near the natural surface of the bone. Rampton (personal communication 1976) suggests that this specimen is of pre- early Wisconsin age.

Discussion

Although I cannot definitely identify the specimen,

it is reminiscent of part of a bowhead whale *(Balaena mysticetus)* mandible. In summer these large whales pass through Bering Strait and are occasionally sighted in the Beaufort Sea, where they were much more common prior to the early incursions of whalers, which began at Herschel Island in 1888 (Youngman 1975, p. 123).

Order Carnivora

Family Canidae

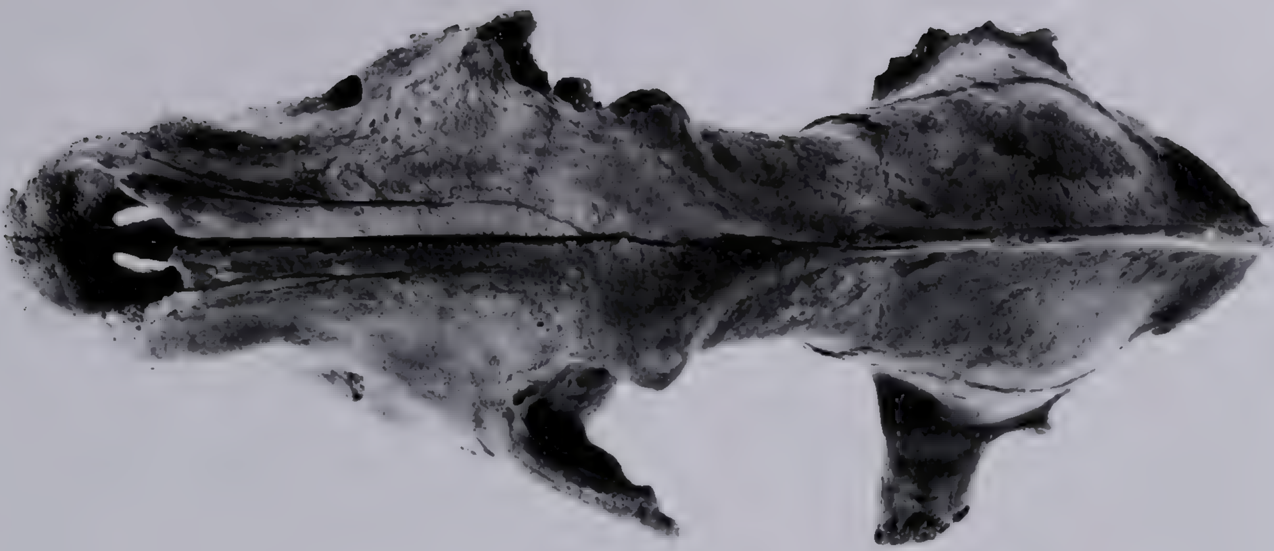
Canis lupus (wolf)

Pleistocene wolf specimens (Figure 28, Tables 25-26) have been found in both Old Crow and Dawson areas. They are often fragmentary. Although many postcranial specimens that are probably referable to wolf have been collected, only some of the more complete cranial material is described. These specimens are mainly separated from those of dholes *(Cuon* sp.*)*, dogs *(Canis familiaris)* and coyotes *(Canis latrans)* on the basis of their larger size - particularly tooth size. Where specimens are sufficiently complete, they usually have M_3s or traces of alveoli for M_3, whereas that tooth is absent in *Cuon*. They have low foreheads, widely spaced cheek teeth, relatively long carnassials (P^4s) and wide M^1s and broad, highly inflated auditory bullae, features which help to separate them from *Canis familiaris*. Harrison's (1973, p. 188, Figure 1) observation

Figure 28. Partial cranium (NMC 9929, Dawson Locality 2) of a Pleistocene wolf *(Canis lupus)*.

A. Dorsal view. B. Left lateral view.

C. Ventral view.

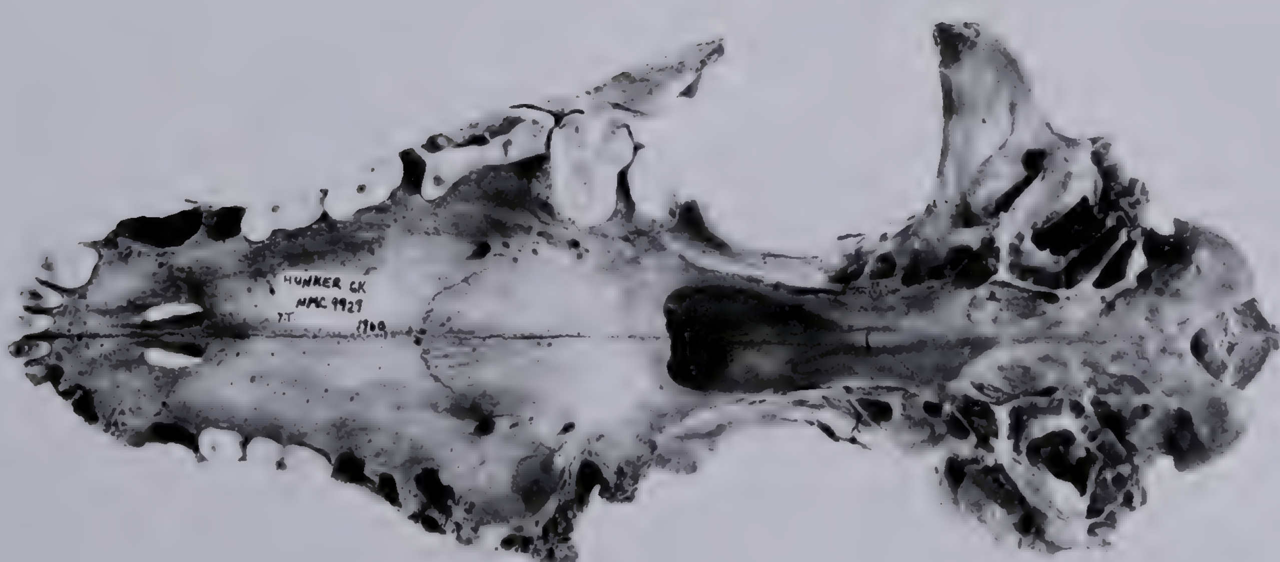


5 CM

A

B

5 CM



5 CM

C

Table 25. Measurements of Pleistocene wolf *(Canis lupus)* crania from the Yukon Territory compared to those of Recent wolves from the Yukon Territory.

SPECIMENS	SEX	Measurements (mm)*												
		1	2	3	4	5	6	7	8	9	10	11	12	13
Canis lupus. Pleistocene, Y.T.														
NMC 9929 Dawson Loc. 2	–	253.6	241.9	124.8	102.8	36.9	66.6	80.8	18.8	50.4	46.9	39.9	108.2	18.1
Uncataloged. Old Crow, near mouth of Johnson Creek.	–	–	–	127.5	–	–	–	–	–	–	49.0	45.5	109.1	17.5
NMC 17377 Dawson Loc. 25	–	–	–	–	–	–	–	–	–	–	–	–	–	–
NMC 20863 Old Crow Loc. 74	–	–	–	–	–	–	–	–	–	–	–	–	–	–
NMC 24939 Old Crow Loc. 11A	–	–	–	–	–	–	–	–	–	–	–	–	–	–
NMC 19476 Old Crow Loc. 65	–	–	–	–	–	–	–	–	–	–	–	–	–	16.9
NMC 24955 Old Crow Loc. 11A	–	–	–	–	–	–	–	–	–	–	–	–	–	–
NMC 17311 Dawson Loc. 7	–	–	–	122.6e	–	34.4e	–	–	–	–	47.0e	–	103.2	17.4
Canis lupus. Recent, Y.T.														
NMC 34690	♂	271.1	254.3	130.8	107.4	35.3	64.9	83.3	19.0	49.8	48.5	44.7	109.8	17.4
NMC 30924	♀	241.7	234.9	122.1	98.9	31.3	64.8	76.0	16.5	48.3	43.3	40.7	104.6	14.8
NMC 30923	♀	238.3	230.2	119.7	95.2	30.3	60.8	77.3	16.6	46.2	44.8	43.8	102.4	15.0
NMC 34691	♂	275.7	256.5	133.0	108.1	34.9	65.7	89.5	20.8	51.9	47.7	43.8	109.6	17.1
NMC 31760	♀	253.3	239.8	119.7	103.0	31.6	67.2	79.1	19.5	49.5	40.7	39.6	105.4	15.6
NMC 18133	?♂	268.9	253.6	126.2	110.5	35.3	68.6	85.9	16.5	54.2	50.4	45.6	112.8	17.7

SPECIMENS	Measurements (mm)*												
	14	15	16	17	18	19	20	21	22	23	24	25	26
Canis lupus. Pleistocene, Y.T.													
NMC 9929 Dawson Loc. 2	–	8.5	6.3	16.9	7.4	17.6	8.1	31.9	14.9	16.5	23.0	9.0	13.7
Uncataloged. Old Crow, near mouth of Johnson Creek.	–	–	–	15.1	6.1	16.4	7.0	27.2	14.8	16.4	20.9	9.8	14.5
NMC 17377 Dawson Loc. 25	–	–	–	–	–	–	–	28.3	14.7	17.4	20.6	8.8	11.5
NMC 20863 Old Crow Loc. 74	–	–	–	14.3	6.3	15.8	–	–	–	–	–	–	–
NMC 24939 Old Crow Loc. 11A	–	–	–	–	–	–	–	23.5	11.6	16.4	17.9	–	–
NMC 19476 Old Crow Loc. 65	–	–	–	–	–	–	–	27.2	16.1	–	–	–	–
NMC 24955 Old Crow Loc. 11A	–	–	–	–	–	–	–	25.9	14.0	–	–	–	–
NMC 17311 Dawson Loc. 7	9.3	7.9	5.5	14.9	5.9	16.9	6.8	27.4	15.3	16.7	20.3	9.3	13.2
Canis lupus. Recent, Y.T.													
NMC 34690	9.6	9.2	5.8	15.3	6.6	16.6	7.3	26.1	14.6	17.0	21.7	9.4	13.8
NMC 30924	9.1	7.3	5.0	13.5	5.9	15.1	6.9	24.5	14.2	16.5	20.6	9.3	14.1
NMC 30923	8.9	8.2	5.5	14.4	6.5	15.9	7.4	25.8	13.9	16.2	21.5	8.9	14.5
NMC 34691	10.3	8.7	5.7	14.9	6.8	17.4	7.7	27.8	15.9	17.6	20.9	9.9	14.4
NMC 31760	9.5	8.9	5.6	15.0	5.9	16.2	6.6	27.1	15.4	17.2	21.8	9.8	14.8
NMC 18133	10.0	7.5	5.5	12.8	6.0	15.1	6.5	25.4	13.8	17.4	21.9	9.3	13.4

* 1 - Greatest length.
2 - Condylobasal length
3 - Palatal length (anterior of premaxilla to posterior of palate)
4 - Postpalatal length (posterior of palate to inferior margin of foramen magnum)
5 - Palatal breadth inside P^2s (minimum)
6 - Width between postglenoid foramina
7 - Postzygomatic width (across squamosal ridges at level of auditory meati)
8 - Basioccipital width (minimum width between auditory bullae).
9 - Width across occipital condyles
10 - Minimum interorbital width
11 - Minimum width of braincase
12 - Alveolar length C^1-M^2
13 - C^1 length (at alveolus)
14 - C^1 width (at alveolus)
15 - P^1 length
16 - P^1 width
17 - P^2 length
18 - P^2 width
19 - P^3 length
20 - P^3 width
21 - P^4 length
22 - P^4 width
23 - M^1 length
24 - M^1 width
25 - M^2 length
26 - M^2 width

Table 26. Measurements of Pleistocene wolf (*Canis lupus*) mandibles from the Yukon Territory compared to those of Recent wolves from the Yukon Territory.

SPECIMENS	SEX	MEASUREMENTS (mm) *																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Canis lupus. Pleistocene, Y.T.																						
NMC 25954 **Dawson Loc. 16	–	36.5	15.7	29.3	13.5	--	–	14.0	6.7	14.7+	7.3	16.7	8.3	31.0	11.9	12.3	8.9	–	–	–	–	–
NMC 25228 Dawson Loc. 32	–	37.5	15.8	–	–	–	–	–	–	–	–	–	–	33.5	12.8	11.8	9.5	5.5	5.4	–	48.8	–
NMC 28862 Old Crow Loc. 66	–	27.4	11.5	22.5	10.6	–	–	–	–	14.6	6.2	16.0	7.4	26.7	10.4	10.8	7.9	–	–	–	–	–
NMC 13595 Old Crow Loc. 11A	–	27.8	11.9	23.2	9.6	–	–	–	–	–	–	–	–	25.3+	9.5+	10.4	7.3	–	–	46.0	40.6	85.1
NMC 28866 Old Crow Loc. 66	–	27.3	12.1	21.8	10.3	–	–	–	–	–	–	–	–	25.2	9.8	10.3	8.0	–	–	45.8	39.8	84.2
OCR 9262 Old Crow Loc. 11A	–	–	–	–	10.2	5.2	4.0	11.5	5.2	12.1	5.4	13.4	6.2	–	–	–	–	–	–	48.9	–	–
NMC 18335 Old Crow Loc. 29	–	–	–	29.2	14.1	6.2	5.3	13.8	7.2	15.9	7.5	17.4	9.0	–	–	–	–	–	–	51.0	–	–
NMC 18716 Old Crow Loc. 29	–	–	–	28.6	12.2	6.0	5.1	13.6	6.6	15.4	7.4	17.3	8.2+	–	–	–	–	–	–	52.1	–	–
NMC 24902 Old Crow Loc. 11A	–	33.2	15.4	–	–	–	–	–	–	–	–	15.6	–	27.6	9.5	–	–	–	–	–	44.4	–
NMC 13579 Old Crow Loc. 11A	–	29.7	12.0	–	–	–	–	–	–	–	–	–	–	–	–	12.0	7.7	–	–	–	–	–
NMC 15902 Old Crow Loc. 44	–	–	–	22.0	10.8	–	–	13.6	5.9	–	–	–	–	–	–	–	–	–	–	–	–	–
NMC 20340 Old Crow Loc. 64	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	12.9	9.0	–	–	–	–	–
NMC 27706 Old Crow Loc. 66	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10.9	7.8	–	–	–	–	–
Canis lupus. Recent, Y.T.																						
NMC 34690	♂	37.9	16.9	30.5	14.7	6.6	5.0	14.4	6.6	15.6	7.1	17.2	8.3	29.5	12.0	12.5	9.2	7.3	6.2	54.8	48.5	101.6
NMC 30924	♀	34.7	14.2	29.7	13.4	5.6	4.6	12.4	6.1	13.4	6.7	15.6	7.8	27.1	10.7	11.9	8.4	5.8	5.2	52.5	44.9	96.5
NMC 30923	♀	30.2	12.8	26.0	10.9	6.5	4.7	12.9	6.4	13.7	6.7	15.9	7.9	28.5	11.0	12.5	8.7	6.1	5.7	52.4	45.9	96.8
NMC 34691	♂	39.1	17.5	32.3	16.7	6.5	5.1	14.1	6.7	15.6	7.5	16.8	8.5	30.1	12.4	12.6	9.6	6.9	6.5	54.6	49.0	103.4
NMC 31760	♀	31.2	13.6	25.0	11.9	7.0	4.8	12.8	5.8	14.6	6.7	16.5	7.8	30.6	12.2	13.0	9.8	5.9	5.4	52.6	48.4	99.6
NMC 18133	♂?	38.1	15.2	26.6	14.4	6.1	4.7	12.8	5.9	14.4	6.6	15.9	7.6	29.6	11.9	12.8	9.3	7.1	6.3	50.5	48.1	98.4

* 1 - Mandible depth below centre of M_1

2 - Mandible width below centre of M_1

3 - Mandible depth below point between P_3 and P_4

4 - Mandible width below point between P_3 and P_4

5 - Length P_1

6 - Width P_1

7 - Length P_2

8 - Width P_2

9 - Length P_3

10 - Width P_3

11 - Length P_4

12 - Width P_4

13 - Length M_1

14 - Width M_1

15 - Length M_2

16 - Width M_2

17 - Length M_3

18 - Width M_3

19 - Alveolar length P_1-P_4

20 - Alveolar length M_1-M_3

21 - Alveolar length P_1-M_3

** Specimen has no M_3

that large *Canis familiaris* skulls can readily be distinguished from small *Canis lupus arabs* and *C. l. pallipes* crania from the Arabian region on the basis of the strikingly larger auditory bullae in wolves, aids in separating North American wolves and dogs in a limited cranial sample I have tested. The efficiency of this criterion for distinguishing between these canids requires further research.

Specimens NMC 28862, 28866, 15902 and 27706 possibly indicate that relatively small-jawed wolves lived in the Old Crow Basin prior to late Wisconsin time, perhaps during the late Illinoian or Sangamon. However, if further work shows the validity of this distinction, probably these wolves would only differ at the subspecific level from modern Yukon wolves. Kurtén (1969, p. 110) has observed little if any difference between wolves of Eem (Sangamon) interglacial and Würm glacial times in Europe.

The Dawson fossils are usually manila to dark tan, while the Old Crow specimens are more darkly stained.

<u>Referred specimens</u>

The best preserved specimen is most of a cranium (NMC 9929) from Dawson Locality 2, where it was washed by a

monitor out of a thick hill of muck. The strong development of the saggital crest is suggestive of a male, whereas the heavy wear on the teeth, particularly the incisors, indicates a mature to old individual. Both zygomatic arches are broken. All teeth of the right side are lacking except for RI^1, RP^1 and RP^2. The canine (LC^1) and LP^1 are missing from the left side, and the outer face of the left carnassial has been broken off. Auditory bullae are damaged, and the tip of the left nasal is lacking. The specimen is stained yellowish brown to brown. The teeth are whitish and relatively fresh in appearance. An uncataloged specimen, collected by a member of W.N. Irving's field crew, came from a gravel bar near the mouth of Johnson Creek in the Old Crow Basin. It consists of the right side of the cranium (lacking the nasal, parietal, temporal, zygomatic arch, occipital region, RC^1 and RP^1) and the left frontal region. The cranium is approximately the same size as NMC 9929, but the teeth are slightly smaller except for LM^2. According to the degree of wear on the teeth, the age of the individual represented by this specimen is a little younger than that of the wolf represented by NMC 9929. The bone and teeth of this specimen are stained dark reddish brown. I suggest, on this basis, that it is of pre- late Wisconsin age.

NMC 17311 from Dawson Locality 7 is a right facial region with all teeth, excepting RI^2, and including anterior parts of the frontal and malar bones. Tooth wear is similar to that of NMC 9929: the fossil may represent an old individual. The RC^1 seems to have been broken and worn smooth later. The specimen is dark tan. NMC 17377 from Dawson Locality 25 is a right maxillary fragment with RP^4-RM^2 and the alveolus for RP^3. The teeth are well worn suggesting that the animal it represents was of mature to old age when it died. The fossil is tan. NMC 24939 from Old Crow Locality 11A is a right maxillary fragment with RP^4-RM^1. The teeth show virtually no wear, indicating a relatively young age at death. The specimen is stained dark brown. NMC 19476 from Old Crow Locality 65 is a right maxilla with RP^4 (the posterointernal portion is lacking) and alveoli for the remaining teeth, except for RM^1 and RM^2. The degree of wear on RP^4 indicates that the individual represented was of similar age to the wolf represented by the fossil from Johnson Creek. The RC^1-RP^4 alveolar length of NMC 19476 is 87.8 mm compared to 90.1 mm for the Johnson Creek fossil. The specimen is tan colored. NMC 24955 from Old Crow Locality 11A is a maxillary fragment with LP^4, the posterior of which is damaged. The teeth show very slight wear. The black staining of the teeth may indicate a pre- late Wisconsin age for the fossil.

Mandibles are better preserved because of their solid bone and compact shape. The most complete specimen, NMC 25954 from Dawson Locality 16, is a right mandible with RP_2-RM_2. The jaw anterior to RP_2 and the posterointernal part of M_1 are missing. RM_3 is not present, evidently a rare case, but there is no chance of mistaking it for a dhole *(Cuon)* mandible because of its large size. Teeth are heavily worn indicating that the mandible is from an old individual. The fossil is tan. NMC 25228 from Dawson Locality 32 is the posterior of a left mandible including the ascending ramus with LM_1-LM_3. The teeth are not quite so heavily worn as those in NMC 25954. The specimen is light tan.

NMC 28862 from Old Crow Locality 66 is a right mandible fragment with RP_3-RM_2. It may represent a young adult as there is little wear on the teeth. The mandible is blackish brown and the teeth are marbled gray and black. NMC 13593 from Old Crow Locality 11A is a right mandible with RM_1-RM_2. Alveoli for the remaining teeth are present. The two anterior cusps of RM_1 are badly damaged. The bone of this specimen is stained reddish brown. Cusps seen on RM_1 and RM_2 are virtually fresh, suggesting that the fossil represents an immature to young adult wolf. Regardless of the possible chronological age of the individual represented

by the fossil, it may have belonged to a rather small-jawed form. It has a deeper mandible than any coyotes *(Canis latrans)* to which it was compared, and cannot be a dhole *(Cuon* sp.) because the alveolus for M_3 is present. NMC 28866 from Old Crow Locality 66 is a left mandible with LM_1-LM_2 and alveoli for the remaining teeth. The teeth show little wear.

OCR 9262 from Old Crow Locality 11A was collected in 1975 by a member of W.N. Irving's field crew. It is the anterior part of a right mandible with RP_1-RP_4 and the alveoli for the canine tooth and incisors. Cusps show moderate wear. The specimen is stained blackish brown. NMC 18335 from Old Crow Locality 29 is the anterior part of a right mandible with RP_1-RP_4 and the alveoli for the canine and incisors. The teeth are slightly worn. The mandibular bone is stained dark reddish brown, whereas the teeth are marbled gray and black. Presumably it and NMC 28862 from Old Crow Locality 66 had undergone a similar history of fossilization. NMC 18716 from the same locality is a left mandible with LP_1-LP_4. The central part of the crown of LP_4 is missing. The teeth are moderately worn, suggesting that the specimen represents an adult. The jaw is stained brown, while the teeth are lighter.

NMC 24902 from Old Crow Locality 11A is a left mandible fragment with LP_4-LM_1, the alveolus for LM_2 and a trace of the alveolus for LM_3. LP_4 is badly damaged. The teeth, particularly LM_1, are extremely heavily worn and the roots are exposed well above the alveolar margin. The wolf represented was very old at death. The mandible is stained reddish brown on the outside and dark brown on the inside. NMC 13579 from the same locality is a posterior mandible fragment with a partial LM_1 and a complete LM_2. Teeth are moderately worn. The specimen is stained blackish brown. NMC 15902 is a left mandible fragment with LP_2 and LP_3 (lacking the posterior cusp and part of the posterior root). The teeth are moderately worn. The specimen was excavated from the fossiliferous zone overlying the basal clay unit at Old Crow Locality 44 and may be of Sangamon interglacial age. It is stained grayish brown. NMC 20340 from Old Crow Locality 64 is the posterior part of a left mandible with a heavily worn LM_2 and the alveoli for LM_3 and the posterior root of LM_1. It is grayish brown and has a fine grayish sand matrix adhering to its inner surface. Although the specimen was found on the river bank, it probably came from the organic gray sandy silt layer above the basal clay unit, which I consider to be of possible Sangamon interglacial age. NMC 27706 from Old Crow Locality 66 is a posterior left mandible fragment with LM_2 and the alveolus for LM_3. LM_2 shows moderately heavy wear. The specimen is stained black.

Discussion

Specimens derived from organic deposits at Old Crow Localities 44 and 64 indicate that wolves occupied the Old Crow Basin during the ?Sangamon interglacial. Fossils from the Dawson Area are probably of late Wisconsin age (Harington and Clulow 1973, p. 699).

In Canada, beyond the Yukon Territory, specimens of wolves or wolf-like animals have been reported from various Pleistocene and postglacial sites. The earliest of these reports is of the Etruscan wolf *(Canis* cf. *etruscus)* from the Kansan fauna at Medicine Hat, Alberta (C.S. Churcher, personal communication 1975). *Canis lupus* and *Canis* sp. (probably a wolf) are known from Sangamon interglacial or mid- Wisconsin interstadial deposits at Medicine Hat and Fort Qu'Appelle, Saskatchewan, respectively (Stalker and Churcher 1970; Khan 1970, p. 13). At Medicine Hat, the dire wolf *(Canis* cf. *dirus)* has been reported from late Wisconsin deposits, while *C. lupus* fossils have come from two beds of late Wisconsin age estimated to be 15,000 and 11,000 years old (Stalker and Churcher 1970). The only other Canadian specimen attributed to the dire wolf is a canine tooth found on the surface near the head of the Castleguard River in Banff National Park, Alberta (Cowan 1954, p. 44). *Canis lupus*

is also a member of the postglacial fauna (approximately 5,000 years old according to radiocarbon dates) at Oxbow Dam, Saskatchewan (Nero and McCorquodale 1958, p. 88). Thus, there appear to be no earlier records of *Canis lupus* in Canada than those of Sangamon interglacial age.

The earliest Alaskan record of a canid *(Canis* sp.), possibly a wolf, is from the Cape Deceit Formation (?Nebraskan) on Kotzebue Sound (Guthrie and Matthews 1971, p. 496). Wolf *(C. lupus)* specimens are not uncommon in muck deposits of Wisconsin age near Fairbanks, and *Canis* sp. has been collected from Illinoian beds there (Péwé 1975a, pp. 96-97). Wolf material has been identified by C.A. Repenning at a late Pleistocene site on Canyon Creek in the Big Delta area (Weber 1975, p. 67). I have not identified dire wolf fossils from the Yukon Territory, and Frick's (1930, p. 79) report of this wolf *("Aenocyon dirus alaskensis")* has not been substantiated. Apparently *Canis lupus* dominated the Beringian region in the late Pleistocene, while the dire wolf was most common in the southern refugium during that period.

In Siberia, *Canis* sp. (possibly a wolf) has been identified from the Olyor Suite (?Kansan) by Sher (1971), and *Canis lupus* is known from late Pleistocene (Illinoian

to Wisconsin?) deposits on Bolshoi Lyakhov Island (Vangengeim 1961). The wolf is also known from the early Wisconsin Iedoma Suite of the Kolyma Lowland (Sher 1971). The species has a long fossil record in China too, beginning with relatively small forms in the Mindel (?Kansan) deposits of Choukoutien (Kurtén 1968, p. 110).

Canis lupus first appears in Europe during the late Günz (?late Nebraskan) and is common in the Cromer (?Aftonian) and Mindel (?Kansan) of England and Germany. These early, relatively small wolves called *C. l. mosbachensis* were replaced by a larger form during the late Pleistocene. Living wolves of northern Europe are smaller than the late Pleistocene form (Kurtén 1968, p. 110).

The Etruscan wolf *(Canis etruscus)*, of sheep dog size, seems to be the most likely ancestor for the living wolf *Canis lupus*. Etruscan wolves occupied Europe throughout the Villafranchian and may have spread to North America by ?Nebraskan (Cape Deceit) or Kansan (Medicine Hat) time. *Canis lupus* seems to have evolved in Europe during the Günz (?Nebraskan) glaciation and spread rapidly into Asia, reaching America by Illinoian time. It is interesting to speculate that the dire wolf may have arisen during the late Pleistocene from a Holarctic *etruscus*-like

stock, and held sway in the southern refugium until the late Wisconsin, when its specialized prey (e.g. *Bison latifrons?)* died out, leaving the way clear for the more adaptable *C. lupus*. The only other North American wolf species, the red wolf *(Canis niger)*, may have greater affinities with *C. etruscus* than *C. lupus*. Detailed comparisons of the skeletal structure of the Etruscan wolf and red wolf would be interesting.

Wolves are lanky, narrow-chested canids that have an extremely broad Holarctic distribution. They are found throughout most of Canada, including all of the Yukon Territory where no well marked subspecies occur (Youngman 1975, p. 128). Their climatic tolerance is so great that they can live in tundra, forest, steppe and desert regions. Because of its adaptability, *Canis lupus* has virtually no value as a paleoenvironmental indicator. Pups are born in dens in early May in Canada. Wolves are gregarious, and make efficient use of their strength by employing various tactics, such as co-operative pursuit of game. Moose, caribou, wapiti, mule deer, white-tailed deer, mountain sheep, bison and muskoxen are among their major prey. Hares, ground squirrels, birds, fishes and berries are less important dietary items. Wolf populations appear to be regulated by abundance of prey, and occasionally by

diseases. During the last few hundred years man has become an important predator of the wolf.

Canis familiaris (domestic dog)

Two specimens (Figure 29A-B, Tables 27-28) possibly derived from Yukon Pleistocene deposits are referred to the domestic dog. Both represent a relatively small-toothed, short-snouted canid that can be distinguished from other members of the Canidae reported from Pleistocene deposits of Eastern Beringia, such as the wolf *(Canis lupus)*, the coyote *(Canis latrans)* and the dhole *(Cuon* sp.*)*. This could indicate the presence of people on the arctic coast of the Yukon in pre- Wisconsin time, and in the Dawson Area during the late Wisconsin glaciation, but the geological age of the specimens must remain conjectural until an adequate method can be found to date them.

Referred specimens

NMC 29047A from Dawson Locality 29 is a cranium with LI^1-LI^3, LP^3-LM^2; RI^2, RP^4-RM^2 and alveoli for the remaining teeth. The slight tooth wear and the degree of suture fusion suggest that the dog represented by the skull died in early maturity. Zygomatic arches are slightly eroded and the sagittal crest is damaged. The surface of the specimen is stained brown to dark brown suggesting a

Figure 29. Right mandible (NMC 10489, Herschel Island Locality 6) of a ?Pleistocene domestic dog *(Canis familiaris)*. A. Lateral view. B. Occlusal view.

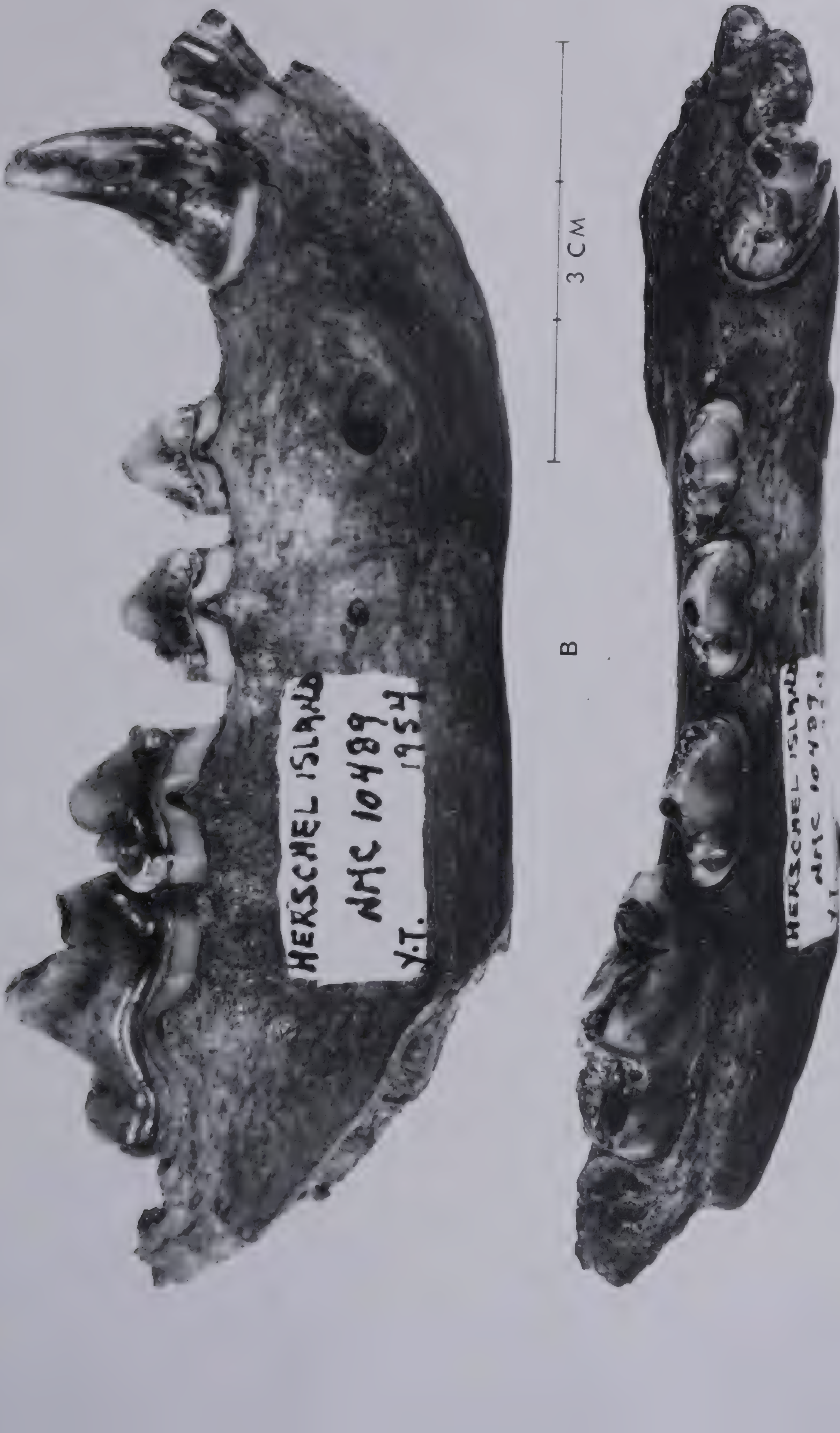

3 CM
B
A
HERSCHEL ISLAND
NMC 10489
Y.T.
1954

Table 27. Measurements of a ?Pleistocene domestic dog *(Canis familiaris)* cranium from the Yukon Territory compared to crania of Recent domestic dogs from northern Canada and Greenland.

SPECIMEN	SEX	AGE (yrs.)	MEASUREMENTS (mm) *																									
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Canis familiaris. ?Pleistocene, Y.T.																												
NMC 29047A Dawson Loc. 29	–	–	208.1	201.5	102.8	87.9	30.5	59.8	73.8	18.5	43.4	36.6	32.9	86.3	14.3	8.0	–	–	–	–	13.7	5.7	20.0	10.9	14.0	16.6	8.1	11.6
Canis familiaris. Recent																												
NMC 36085 Ellesmere I., N.W.T.	♂	–	211.9	216.5	112.3	91.8	38.7	62.7	76.9	21.6	46.0	41.3	41.2	93.7	15.0	9.2	6.5	4.9	13.7	5.9	15.3	6.8	22.0	13.1	13.9	18.9	7.8	12.0
NMC 36086 Ellesmere I., N.W.T.	–	4	237.7	230.6	122.9	93.3	39.0	70.5	92.9	20.0	49.3	49.1	44.9	102.7	16.2	9.9	6.3	4.5	12.0	5.7	13.9	7.3	22.2	13.9	14.2	20.0	8.4	12.9
NMC 36088 Ellesmere I., N.W.T.	♂	7	207.4	204.2	102.9	88.2	–	59.1	75.5	17.6	42.7	37.4	38.8	89.5	14.2	9.1	5.0	4.4	10.6	4.5	12.9	5.9	20.8	11.8	13.0	17.9	7.2	11.8
NMC 35222 Ellesmere I., N.W.T.	♂	8	226.0	221.5	114.4	93.9	36.0	61.3	78.8	18.7	46.0	44.9	39.6	95.9	13.4	8.8	5.5	4.2	11.9	5.0	13.4	5.7	22.0	11.7	13.3	18.6	8.2	11.9
NMC 35221 Ellesmere I., N.W.T.	♂	2	230.0	224.3	113.1	93.8	37.6	63.9	83.3	18.0	48.2	44.8	42.2	97.3	15.6	9.0	6.2	4.6	12.7	5.7	14.7	7.3	21.6	13.6	13.2	18.1	7.6	12.7
NMC 35223 Ellesmere I., N.W.T.	♂	6	235.7	222.4	112.2	94.3	38.3	64.0	79.3	20.4	47.7	40.7	41.2	97.5	15.3	8.8	6.2	4.5	12.1	5.6	14.5	6.9	22.2	12.7	13.9	18.8	7.5	11.4
NMC 35220 Ellesmere I., N.W.T.	♂	8	226.4	226.0	119.0	93.9	36.8	60.8	77.9	18.3	43.6	47.8	43.2	98.9	13.3	8.3	5.8	4.6	13.3	5.4	14.8	6.4	21.6	12.0	13.7	18.7	8.8	12.4
NMC 35219 Greenland	♂	–	228.6	213.0	110.8	89.3	35.0	61.6	78.5	17.3	45.1	42.1	43.4	91.8	14.1	8.2	6.5	4.2	12.8	5.3	14.7	6.3	–	–	13.9	19.8	8.6	12.7
NMC 9536 Greenland	–	–	–	216.8	111.0	92.4	36.3	61.3	77.1	20.7	45.1	39.7	40.9	92.5	12.5	8.5	6.4	4.5	10.8	5.2	13.5	5.8	–	–	14.3	18.5	8.1	12.3
NMC 19820 Y.T.	–	–	200.9	195.4	101.4	85.0	31.5	57.2	70.6	18.3	41.5	39.3	40.1	85.4	12.2	7.9	5.7	3.6	10.9	4.7	12.9	5.4	19.9	10.2	13.3	16.2	7.7	10.4
NMC 31817 N.W.T.	♀	–	176.5	178.9	89.7	76.6	27.0	56.2	68.9	16.9	41.8	32.4	31.9	78.1	11.8	7.7	6.2	4.3	10.4	4.9	12.6	6.8	20.9	11.2	13.3	17.1	8.1	11.1
NMC 31818 N.W.T.	♂	–	217.3	214.9	109.2	93.3	31.4	62.0	79.4	18.9	45.4	43.1	38.9	90.9	14.7	8.7	–	–	11.4	5.0	13.9	5.9	20.4	10.8	13.6	17.5	8.0	11.2

* 1. Greatest length. 2. Condylobasal length. 3. Palatal length (anterior of premaxilla to posterior of palate). 4. Postpalatal length (posterior of palate to inferior margin of foramen magnum). 5. Palatal breadth inside P^2s (minimum). 6. Width between postglenoid foramina. 7. Postzygomatic width (across squamosal ridges at level of auditory meati). 8. Basioccipital width (minimum width between auditory bullae). 9. Width across occipital condyles. 10. Minimum interorbital width. 11. Minimum width of braincase. 12. Alveolar length C^1–M^2. 13. C^1 length (at alveolus). 14. C^1 width (at alveolus). 15. P^1 length. 16. P^1 width. 17. P^2 length. 18. P^2 width. 19. P^3 length. 20. P^3 width. 21. P^4 length. 22. P^4 width. 23. M^1 length. 24. M^1 width. 25. M^2 length. 26. M^2 width.

Table 28. Measurements of a ?Pleistocene domestic dog *(Canis familiaris)* mandible from the Yukon Territory compared to mandibles of Recent domestic dogs from northern Canada and Greenland.

SPECIMENS	SEX	AGE (yrs.)	MEASUREMENTS (mm) *																				
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Canis familiaris.?Pleistocene, Yukon Territory																							
NMC 10489	-		-	11.4	19.8	9.8	-	-	8.6	4.3	9.9	5.0	11.8	6.1	21.4	8.9	-	-	-	-	-	-	-
Canis familiaris.Recent																							
NMC 36085 Ellesmere I. N.W.T.	♂		30.3	15.0	27.0	12.7	4.8	4.8	11.5	5.8	13.8	6.8	14.3	8.0	26.2	11.3	9.4	8.0	4.6	4.3	48.2	39.7	86.2
NMC 36086 Ellesmere I. N.W.T.	-	4	36.0	14.8	28.7	14.2	5.6	3.9	9.6	4.5	11.6	6.2	13.0	7.5	26.0	11.2	10.8	7.6	4.6	4.4	51.9	40.3	91.4
NMC 36088 Ellesmere I. N.W.T.	♂	7	29.6	13.2	24.5	11.4	5.0	4.0	8.6	4.6	11.2	5.5	12.8	6.9	23.6	10.1	9.1	7.2	4.8	4.3	43.8	38.6	81.0
NMC 35222 Ellesmere I. N.W.T.	♂	8	33.2	15.1	25.0	13.5	-	-	10.0	4.8	12.4	5.9	12.5	6.7	24.9	10.5	9.2	6.8	4.5	3.9	-	37.1	-
NMC 35221 Ellesmere I. N.W.T.	♂	2	32.5	14.5	27.9	12.7	5.2	4.1	10.2	5.4	12.3	6.4	14.2	8.0	25.4	11.4	10.2	8.1	5.1	5.1	49.2	39.4	87.6
NMC 35223 Ellesmere I. N.W.T.	♂	6	32.6	14.3	27.6	12.6	4.7	3.5	11.1	5.4	12.6	5.2	13.8	7.8	24.7	10.6	10.1	7.6	5.4	4.8	47.5	40.2	85.5
NMC 35220 Ellesmere I. N.W.T.	♂	8	32.4	15.3	28.2	12.7	4.9	4.0	11.2	5.2	12.0	7.3	13.8	7.1	24.4	10.8	10.7	7.8	5.7	5.1	48.5	39.8	88.0
NMC 35219 Greenland	♂	-	30.7	13.3	26.3	11.9	5.0	3.6	11.5	5.1	12.2	5.8	14.2	7.0	24.5	10.2	10.5	7.6	6.3	5.5	43.7	40.5	83.2
NMC 9536 Greenland	-	-	30.5	12.8	26.2	11.3	4.7	3.7	9.1	4.5	12.1	6.1	12.8	6.2	24.7	9.6	10.5	7.2	6.2	5.2	48.0	40.6	88.3
NMC 19820 Y.T.	-	-	26.5	12.0	23.8	11.2	4.6	3.4	8.7	4.9	10.8	5.3	12.5	6.2	22.5	9.3	9.2	7.5	4.6	4.3	43.0	35.9	77.7
NMC 31817 N.W.T.	♀	-	24.1	11.2	19.2	10.3	-	-	9.3	4.7	10.8	5.5	12.8	6.3	22.3	9.0	9.2	7.1	4.7	4.2	-	36.0	-
NMC 31818 N.W.T.	♂	-	28.6	13.5	22.8	12.0	4.1	3.8	9.6	4.8	11.8	5.6	13.3	7.0	24.2	9.9	9.5	7.6	-	-	45.0	38.9	83.8

* 1. Mandible depth below centre of M_1. 2. Mandible width below centre of M_1. 3. Mandible depth below point between P_3 and P_4. 4. Mandible width below point between P_3 and P_4. 5. Length P_1. 6. Width P_1. 7. Length P_2. 8. Width P_2. 9. Length P_3. 10. Width P_3. 11. Length P_4. 12. Width P_4. 13. Length M_1. 14. Width M_1. 15. Length M_2. 16. Width M_2. 17. Length M_3. 18. Width M_3. 19. Alveolar length P_1-P_4. 20. Alveolar length M_1-M_3. 21. Alveolar length P_1-M_3.

late Pleistocene age, but it could be of postglacial or even historic age. The specimen was washed out from a cut made by A. Sailer on the left limit of Dominion Creek in 1975. A third cervical vertebra was recovered with the cranium, perhaps indicating that a partly articulated specimen was preserved in the deposits.

This cranium has a markedly elevated forehead (or "stop" in the parlance of modern dog fanciers), relatively small teeth, and a tendency to flattening of the auditory bullae, which are among cranial characters customarily found reliable in separating northern forms of *Canis lupus* from *Canis familiaris* (Harrison 1973, p. 186). Also, the length of the carnassial is less than the combined length of M^1 and M^2 (Clutton-Brock 1969, p. 304). The specimen is larger than modern coyote skulls examined, and it differs from the dhole in its much greater length of snout (i.e. anterior to P^3s), the elevated forehead (which tends to be convex rather than concave in the dhole), and the relatively large M^2s (which appear almost vestigial in relation to M^1s in the dhole).

Another interesting point of difference from the other canids mentioned, is the inward convexity of NMC 29047A, which is most pronounced near the anterior margin

of P^3s where the palatal breadth measured at the outer margins of the teeth rapidly decreases by approximately 40%. The maxillary teeth taper inward anteriorly more gradually in specimens of wolf, coyote and dhole that have been examined. In a sense, this can be considered as a "lateral stop". It is a characteristic feature of other domestic dogs, but perhaps not all dogs.

Plotting the values of basioccipital width against postzygomatic width and carnassial length plus M^1 width against the C^1-M^2 alveolar length for NMC 29047A on the scattergrams used by Harrison (1973, pp. 188-189) to separate dogs from wolves, this Yukon dog seems to be relatively large and is near the limit between dogs and wolves. A scattergram of this nature did not separate completely the North American sled dogs and wolves used for comparison in this study, although NMC 29047A was well within the domestic dog zone, and the Pleistocene wolf NMC 9929 lay within the wolf zone.

NMC 10489 from Herschel Island Locality 6 is a right mandible with RI_2-RI_3, RC_1 and RP_2-RM_1. The alveoli for RI_1 and the anterior root of RM_2 are also evident. RP_1 is not present. P_1s are often absent in domestic dogs, but almost never in wild canids (B. Lawrence, personal

communication 1975). All teeth show moderate wear, indicating that the individual represented by the fossil was mature at death. The mandible is shorter, deeper and generally more robust than those of coyotes *(Canis latrans)* that I have seen. The small size of the heel of M_1 with greatly reduced entoconid and very small metaconid, the shortness of P_4 posterior to the main cusp, and the short, thick canine (10.2 mm x 6.3 mm x 15 mm high) also help to distinguish the specimen from coyote mandibles. NMC 10489 has two cusps on the posterior margin of M_1, unlike the dhole *(Cuon* sp. *)* which has only one - a centrally placed hypoconid and no entoconid. The specimen's small size and shortness, in conjunction with the apparently mature chronological age of the individual represented, distinguishes it from the wolf *(Canis lupus)* and the dire wolf *(Canis (Aenocyon) dirus)*. I am grateful to Barbara Lawrence for confirming my identification of NMC 10489 as *Canis familiaris*. Her conclusion was based on examination of a good cast.

A rather similar specimen called a "Birnirk dog" has been illustrated by Bee and Hall (1956, pp. 172-173). Like the "Birnirk dog" which was excavated from an early Eskimo house near Point Barrow, Alaska, NMC 10489 lacks P_1, and its P_1-M_2 alveolar length of 61.4 mm is not very

different from those provided for three of these dogs: 60.2, 59.6, 61.5 mm. It is markedly smaller than a series of mandibles from Recent huskies, and slightly smaller than some material from a Dorset Eskimo site on Mill Island just north of Hudson Bay in the collections of the Museum of Comparative Zoology, Harvard University (B. Lawrence, personal communication 1975). It is interesting to note Møhl's comment that dogs from the early archeological site at Trail Creek, Alaska are considerably smaller than Eskimo dogs of the present day (Larsen 1968).

NMC 10489 was collected by R.S. McNeish in 1954 from the southwesternmost spit of Herschel Island. He recorded that it was "associated with mammoth ivory". Many Pleistocene vertebrate fossils have been found along the coasts of Herschel Island. Among them are specimens of the woolly mammoth *(Mammuthus primigenius)*, Yukon wild ass *(Equus (Asinus) lambei)*, large-horned bison *(Bison* cf. *crassicornis)*, extinct muskox (?*Böötherium* sp.), and tundra muskox *(Ovibos moschatus)* (Harington 1976 MS, p. 59). I suspect that the dog mandible is of Pleistocene age because both the mandibular bone and teeth are stained dark brown to black, which, using the rule-of-thumb apparently applicable to permineralization of fossils in the Dawson and Old Crow areas, would suggest a pre- late Wisconsin age.

Discussion

The potential scientific value of these specimens lies in determining their age. As they were not found in place in sedimentary deposits, the stratigraphic method of dating them is inapplicable. Nor can radiocarbon dating be reasonably employed, for it would mean destroying specimens of possibly great significance. In view of these facts, arrangements have been made to submit small samples of the bone and teeth to N. Rutter, University of Alberta, for amino acid racemization dates (Anonymous 1975a, p. 349). If not useful in the "absolute" sense, the results should at least be useful in terms of relative age.

No dogs of Pleistocene age have been reported from Canada or Alaska (the exact age of the Trail Creek dogs are not known). However, among the earliest recognized dog fossils in the world are those excavated at Jaguar Cave, Idaho (Lawrence 1967, 1968). Here, small dogs, similar in size to Basket Maker dogs of the Southwest, and large husky-like dogs lived together about 11,000 years ago south of the retreating Wisconsin ice. These data imply that domestication took place long before 11,000 years ago, and that hunters entering Alaska and the Yukon from Asia were accompanied by dogs. So it is theoretically reasonable to seek fossils of late Pleistocene dogs in Eastern Beringia.

Perhaps even earlier than the Jaguar Cave dog fossils, is a dog jaw with teeth from a cave at Palegawra, Iraq. An age estimate based on flourine analysis of the bone indicates that dogs were present when people first occupied the Palegawra Cave some 14,000 years ago (Anonymous 1975b, p. 54).

Degerbøl (1961) and La Baume (1962) have argued convincingly that the nearest ancestor of the domestic dog is a small race of *Canis lupus*. Lawrence (1967, p. 57) believes that North American dogs cannot have been domesticated from North American wolves, and suggests that *Canis familiaris* must have stemmed from small wolves, such as the extinct *C. l. variabilis* of the Pleistocene of China and Siberia (Pei 1934, p. 13; Vangengeim 1961, p. 73) or the living Indian wolf *C. l. pallipes*, which Trouessart (1911, p. 909) believed had given rise to all domestic dogs of Europe and Asia and the dingo. Clutton-Brock (1969, p. 307) argues for the Indian wolf as the most likely progenitor of the domestic dog. She states that its skull is extraordinarily similar in size and shape to the dingo and also the Indian pariah dog, with which it freely interbreeds, and that this stock gave rise to the dogs identified from prehistoric sites in western Asia. She also suggests that the much larger dogs from English

(e.g. Star Carr) and Danish sites could have evolved from tamed European wolves. Olsen (1974, p. 345) favors the small race of the Chinese wolf *(Canis lupus chanco)* as an ancestor for the dog. Zeuner (1963, pp. 79-111) provides a wide-ranging account of the history of domestic dogs. On behavioral as well as anatomical grounds, it is assumed that the wolf is the ancestor of the domestic dog.

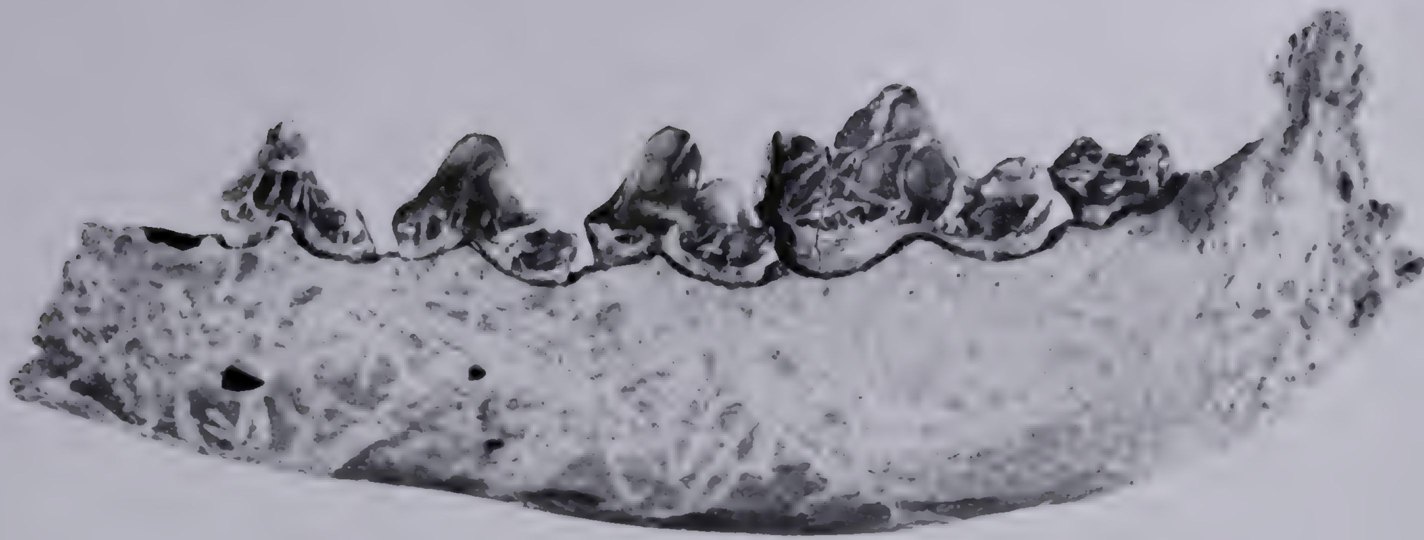
Domestic dogs are remarkable for their variety of sizes, shapes and uses. The American Kennel Club (1975, pp. 7-8) currently recognizes six major groups of dogs: (1) sporting dogs containing 24 breeds including setters, pointers and spaniels; (2) hounds with 19 breeds such as Beagles, Greyhounds and Elkhounds; (3) working dogs containing 30 breeds including Collies, German Shepherds, and huskies; (4) terriers with 22 breeds such as Airdales and Scottish Terriers; (5) toys with 17 breeds such as the Pekingese, and Poodle; (6) non-sporting dogs containing 11 breeds such as Bulldog and Chow Chow. These groups give an idea of the various ways people use dogs. There are many hybrids or mongrels. Domestic dogs are virtually world-wide in distribution - even in Antarctica, where huskies, adapted to survival as working dogs under cold climatic conditions, are used by scientific expeditions.

From a paleoenvironmental viewpoint remains of domestic dogs indicate the presence of man. People often control the reproduction of the animals by selective breeding, spaying, or other means. Like wolves, dogs are gregarious, and Eskimos have made good use of their natural association in packs by harnessing teams of huskies to provide sled transport in winter. Hunters generally provide their dogs with meat from the kill. In more civilized places the animals are given dog food consisting of meat and cereal, occasionally supplemented with bones. These animals sometimes live in dwellings occupied by people, or they may be left outside most of the time, in which case small shelters or kennels are usually provided by their owners. Domestic dogs are often killed by people when they are incapacitated by age, disease or severe injury. Some societies have bred dogs for food. Occasionally domestic dogs are attacked and killed by bears, wolves or large cats such as the mountain lion.

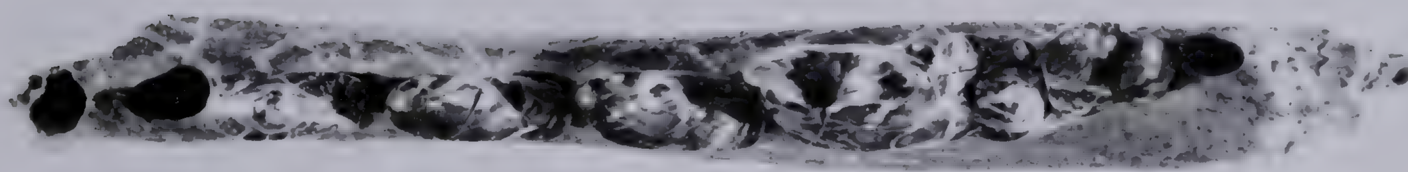
Alopex lagopus (arctic fox)

Although most arctic fox specimens (Figure 30A-D, Table 29) collected from Pleistocene deposits in the Yukon Territory have been collected from the Old Crow Basin, two

Figure 30. Left mandible with LP_2-LM_2 (NMC 29044, Dawson Locality 10) of a Pleistocene arctic fox *(Alopex lagopus)*. A. Lateral view. B. Occlusal view. Right mandible with RP_2-RM_2 (NMC 18329, Old Crow Locality 29) of a Pleistocene arctic fox *(Alopex lagopus)*. C. Lateral view. D. Occlusal view.



A



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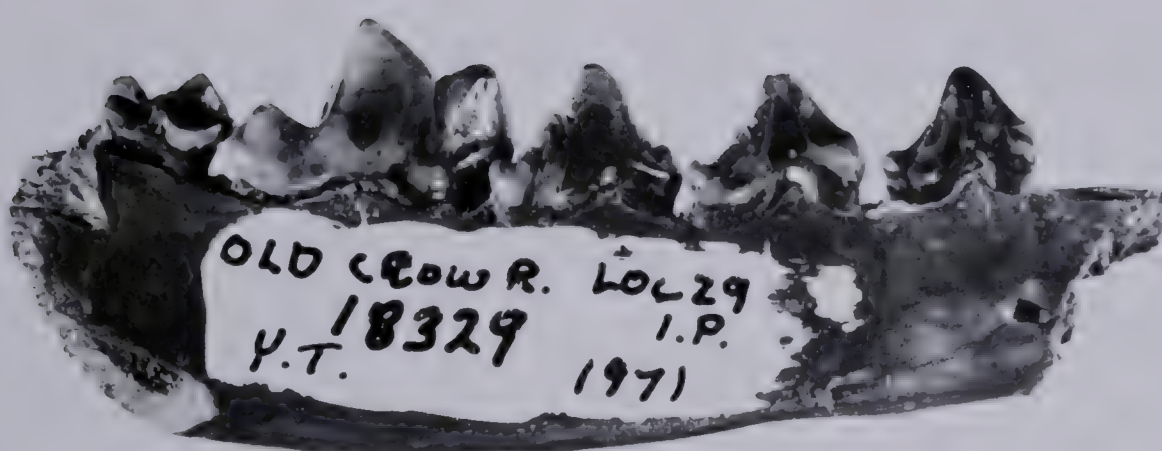

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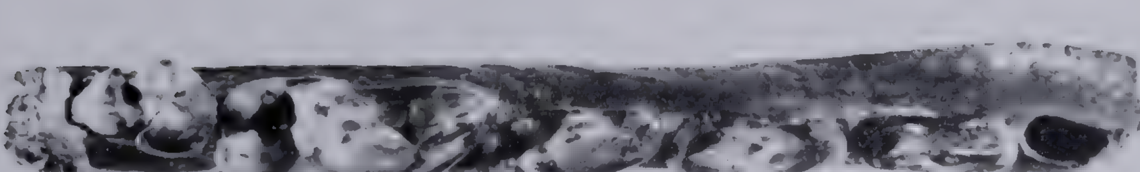


D

Table 29. Measurements of Pleistocene arctic fox (*Alopex lagopus*) mandibles from the Yukon Territory compared to those of Recent arctic foxes and red foxes (*Vulpes vulpes*) from the Northwest Territories and Alaska.

SPECIMENS		SEX	MEASUREMENTS (mm) *																	
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Alopex lagopus, Pleistocene, Y.T.																				
NMC 29044	Dawson Area	-	13.8	6.7	11.6	5.7	7.3	3.1	8.6	3.3	8.8	3.8	13.6	5.7	6.0	4.5	29.0	22.3	4.0	50.7
NMC 18218	Old Crow Loc. 29	-	15.0c	6.9	11.2	6.0	6.6+	3.1	-	-	9.0	4.2	13.5	5.4	6.2	4.4	29.5	21.8	4.4	52.0
NMC 18329	Old Crow Loc. 29	-	12.5	6.1	10.7	5.5	7.1	2.8	8.4	3.1	8.7	3.8	13.1	5.1	6.1	4.3	29.3	-	4.2	-
NMC 20858	Old Crow Loc. 74	-	13.4	6.0	10.3	5.4	-	-	8.6	3.0	8.8	3.8	13.2	4.9	-	-	30.3	21.6	4.5	52.0
NMC 18247	Old Crow Loc. 11A	-	14.6	6.1	11.9	5.5	7.4	3.3	-	-	9.4	4.0	14.1	4.2	-	-	30.8	-	5.0	-
NMC 15363	Old Crow Loc. 44	-	-		10.5	5.6	7.8	2.9	7.4+	-	-	-	-	-	-	-	-	-	-	-
NMC 18331	Old Crow Loc. 29	-	-	6.0	10.4	5.5	7.3	3.1	-	-	-	-	13.7	5.2	-	-	28.5	-	4.8	-
NMC 14352	Old Crow Loc. 22	-	-	5.1	11.5	5.1	-	-	-	-	-	-	13.5	5.0	-	-	30.0	-	4.4	-
NMC 18330	Old Crow Loc. 29	-	13.7	6.2	-	-	-	-	-	-	-	-	13.5	5.0	6.1	4.5	-	-	4.6	-
NMC 22043	Old Crow Loc. 27W	-	-	-	10.3	5.0	7.0	3.0	-	-	-	-	-	-	-	-	28.5	-	-	-
NMC 15579	Old Crow Loc. 28	-	9.1	4.6	9.2	-	-	-	-	-	-	-	-	-	-	-	29.8	-	-	-
NMC 28623	Old Crow Loc. 65	-	-	-	10.4	5.5	-	-	-	-	-	-	-	-	-	-	29.5	-	-	-
NMC 26974	Old Crow Loc. 22	-	-	-	10.4	5.9	-	-	-	-	-	-	-	-	-	-	27.9	-	-	-
NMC 28668	-Old Crow Loc. 27	-	14.1	6.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NMC 18510	Old Crow Loc. 29	-	-	-	9.6	5.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alopex lagopus, Recent, N.W.T.																				
NMC 21308		♂	14.6	6.2	11.9	5.7	-	-	8.2	3.8	8.8	4.4	14.0	5.5	5.7	4.1	29.7	21.1	4.8	50.9
NMC 21307		♀	13.3	5.8	11.6	5.4	7.8	3.4	9.0	3.5	9.9	4.1	14.3	5.6	6.2	4.3	30.3	22.1	4.6	52.5
NMC 21305		♂	13.4	5.9	11.4	5.6	8.0	3.5	8.7	3.6	9.2	4.2	14.4	5.7	6.3	4.5	30.5	22.3	4.6	52.4
NMC 21303		♂	14.5	6.7	11.6	6.0	8.1	3.6	8.9	3.7	9.7	4.7	14.4	5.7	6.2	4.3	29.2	23.4	4.2	52.1
NMC 21309		♂	14.0	6.4	11.9	5.4	8.3	3.5	9.2	3.6	9.9	4.7	15.3	5.5	6.7	4.8	31.6	24.8	5.5	55.8
Alopex lagopus, Recent, Pribilof Is.																				
NMC 30221		♂	16.0	6.3	13.0	6.3	7.0	3.3	7.6	3.5	9.1	4.3	14.0	5.4	6.2	4.3	28.9	22.1	4.4	50.9
NMC 30217		♂	14.9	6.6	12.8	6.9	6.8	3.1	7.8	4.1	8.5	4.1	12.7	5.3	5.5	3.9	28.0	21.0	3.6	49.4
NMC 30215		♂	14.2	5.9	12.2	5.9	7.9	2.9	8.2	3.1	9.1	3.8	13.3	5.2	5.6	4.3	29.8	21.2	4.1	50.8
NMC 30212		♂	14.3	5.9	12.4	6.1	7.4	3.2	7.7	3.1	8.5	3.8	12.4	5.0	5.5	4.1	30.0	20.3	3.7	50.2
NMC 30216		♂	15.1	6.4	12.6	6.0	7.5	3.1	8.2	3.3	9.3	4.3	13.3	5.4	5.4	4.0	30.2	20.3	4.0	50.3
NMC 30220		♂	16.1	6.7	13.0	6.5	6.8	3.0	7.5	3.4	8.6	4.1	12.7	5.0	5.0	4.0	29.7	21.2	3.8	50.5
Vulpes vulpes, Recent																				
NMC 17955	Y.T.	-	16.3	6.6	12.1	6.2	8.8	3.6	10.1	3.4	10.8	4.4	15.7	6.2	6.9	5.2	34.5	24.0	4.9	57.8
NMC 31073	Y.T.	♂	16.2	7.3	13.2	6.7	10.2	3.9	10.4	4.2	11.3	5.2	17.1	6.8	6.9	5.2	38.7	28.0	4.7	66.1
NMC 2434	Alaska	♂	16.1	6.4	12.7	6.4	9.1	3.5	10.0	3.7	11.0	4.2	15.6	6.6	7.5	5.4	34.2	26.0	9.0	59.7
NMC 17956	Y.T.	-	15.6	7.4	13.2	6.3	8.9	3.7	9.9	3.6	10.4	4.7	15.6	6.4	6.6	5.2	37.8	25.8	4.7	63.4
NMC 31729	Y.T.	-	15.6	6.6	13.1	6.2	9.2	3.5	10.2	3.5	10.7	4.3	15.6	6.3	7.7	5.4	38.0	27.2	4.5	64.9
NMC 18132	Y.T.	?♀	15.6	6.4	12.3	6.6	9.4	3.7	10.0	3.8	10.5	4.8	16.7	6.8	7.0	5.4	34.5	24.0	4.9	57.8

* 1. Mandible depth below centre of M_1. 2. Mandible width below centre of M_1. 3. Mandible depth below point between P_3 and P_4. 4. Mandible width below point between P_3 and P_4. 5. Length P_2. 6. Width P_2. 7. Length P_3. 8. Width P_3. 9. Length P_4. 10. Width P_4. 11. Length M_1. 12. Width M_1. 13. Length M_2. 14. Width M_2. 15. Alveolar length P_1-P_4. 16. Alveolar length M_1-M_3. 17. Talonid length M_1. 18. Alveolar length P_1-M_3.

are from the Dawson Area. Mandibles with teeth are most commonly preserved. Fossils of arctic foxes far outnumber those of red foxes *(Vulpes vulpes)* in the Yukon Territory.

Referred specimens

A right maxillary fragment containing RP^4 and partial alveolus for RP^3 (NMC 15723) from Old Crow Locality 28 represents a very old individual according to the degree of tooth wear. The tooth is 12.0 mm long x 5.3 mm wide, lying well below the sampled range for the red fox *(Vulpes vulpes)*. Although slightly smaller than any of the P^4 measurements of six Recent arctic foxes, it most closely matches a female from Tuktoyaktuk, Northwest Territories (NMC 21319) and is referred to *Alopex lagopus*. An RM^1 (NMC 28734) from Old Crow Locality 27 is perfectly preserved except for the roots. It too is relatively small (8.4 mm long x 9.6 mm wide). It compares closely with RM^1s of Recent male (NMC 21308) and female (NMC 21319) arctic foxes from the Northwest Territories. Both fossils are stained brown.

The mandibles described here have some or all of the following characteristics which tend to separate arctic foxes from red foxes: (a) shallower, shorter mandible; (b) relatively poorly developed posterolingual cusp on M_1; (c) distinctly shorter P_1-P_4 alveolar length; M_1-M_3

alveolar length is relatively short, but the difference is not so pronounced.

The best preserved specimen in the collection is a left mandible (NMC 29044) from Dawson Locality 10. It contains LP_2-LM_2 and lacks both the ascending ramus and tip of the mandible anterior to LP_1. Wear on the cusps is noticeable but not heavy. The teeth are stained a darker brown than the mandibular bone. The entire specimen is etched with impressions of rootlets, suggesting deposition in a grassland environment. Fine, micaceous, oxidized silt adheres to the mandible.

A right mandibular fragment (NMC 18329), similar to NMC 29044, containing RP_2-RM_2, was excavated from organic sandy gravel overlying the basal clay unit at Old Crow Locality 29. The specimen is stained dark brown and, according to the slight degree of wear on the cusps, represents a younger fox than NMC 29044. NMC 18218 from Old Crow Locality 29 is a right mandibular fragment with RP_2 and RP_4-RM_2. The roots of RP_4 are exposed well above the alveolar margin. The specimen is reddish brown. NMC 20858 from Old Crow Locality 74 is a right mandible with RP_3-RM_1. The teeth show heavy wear, suggesting that an old individual is represented. It is stained dark brown. Again, rootlet

impressions are seen on the surface of the mandible. Another mandibular fragment with LP_2 and LP_4-LM_1 (NMC 18247) from Old Crow Locality 11A has heavily worn teeth. It is stained blackish brown.

NMC 15863 from Old Crow Locality 44 is important because it indicates the presence of arctic foxes in the Old Crow Basin more than 54,000 years ago, possibly during the Sangamon interglacial. It consists of a left mandibular fragment with LP_2-LP_3 and is stained dark brown. NMC 18331 is a left mandible with LP_2 and LM_1. The teeth are almost black, while the bone is stained brown. It was excavated from deposits overlying the basal clay unit at Old Crow Locality 29. NMC 14352, a right mandibular fragment containing a well worn RM_1 and sockets for RI_1 and RC_1-RP_4, is olive brown. The tooth is darker. The specimen was collected from the base of a sand deposit overlying the basal clay unit at Old Crow Locality 22. NMC 18330 from Old Crow Locality 29 is a left mandibular fragment with LM_1-LM_2 and the socket for LM_3. The tips of the cusps are slightly worn. The entire specimen is stained brown and compares closely with a Recent specimen of a male arctic fox (NMC 21305) from Tuktoyaktuk, Northwest Territories. NMC 22043 from Old Crow Locality 27W is a right mandible with RP_2 and sockets for RP_1 and RP_3-RP_4. The mandible is

very shallow, despite the fact that it represents a mature individual according to heavy wear on RP_2. NMC 15579 from Old Crow Locality 28 is an edentulous right mandible containing alveoli for RC_1-RM_1. It is stained dark brown and is remarkably shallow. I tentatively refer it to a juvenile. NMC 28623, a left mandibular fragment containing sockets for LP_1-LP_4, was excavated at Old Crow Locality 65. The lateral surface has fine scratches and grooves as if it had been gnawed by another small carnivore when the bone was fresh. NMC 16974 is a left mandible with sockets for LP_1-LP_4 from the sand bar opposite to Old Crow Locality 22. It is a blackish brown color and has a burnished surface, which may be due to the action of wind blown sand. NMC 28668 from Old Crow Locality 27 is the posterior part of a left mandible containing sockets for RM_2-RM_3 and the posterior root of RM_1. It is light brown. A left mandibular fragment, NMC 18510, excavated from organic sandy gravel overlying the basal clay unit at Old Crow Locality 29, contains sockets for LP_3 and LP_4. It is stained black.

Approximately 70% of the arctic fox mandibles from Pleistocene deposits of the Old Crow Basin are from localities near, or just upstream from the mouth of Timber Creek. Perhaps a "proto-Timber Creek" concentrated these bones from former loess-steppe (note the rootlet impressions

on some of the fossils) areas on the northern margin of the basin.

The second arctic fox specimen from the Dawson Area is a complete right tibia (NMC 29299) to which a lower segment of the fibula is fused. It was found in place in the muck overlying the gold-bearing gravel at Dawson Locality 10. Radiocarbon dates from bones in stratigraphically similar situations at five different localities in the Dawson Area range in age from approximately 15,000 to 32,000 years B.P.; the average being about 24,600 years B.P. (Harington 1975b, p. 5). Presumably the tibia is of late Wisconsin age. The specimen is fresh-looking, tan in color, and has a total length of 122.8 mm. It is closely comparable to the tibia of a Recent male arctic fox (NMC 14060) from Ellesmere Island, Northwest Territories.

Measurements of the Old Crow and Dawson fossils generally fall within the sampled ranges of those for Recent arctic foxes from the Northwest Territories. An interesting feature of the metric comparisons is that the mandibular depth between P_3 and P_4 varies, averaging 10.6 mm for the Yukon fossils, 11.7 mm for the Recent Northwest Territories specimens and 12.7 mm for Recent specimens from the Pribilof Islands.

Discussion

The arctic fox, like the red fox, probably arose from *Vulpes alopecoides* during the middle Pleistocene in Eurasia, but it is not recorded until the late Riss (Illinoian) glaciation in Europe. There are a few records from Eem (Sangamon) interglacial deposits, but the species evidently did not become widely dispersed until the Würm (Wisconsin) glaciation (Kurtén 1968, p. 116). In north-eastern Siberia, the species has been reported from late Pleistocene (Illinoian to Wisconsin?) deposits on Bolshoi Lyakhov Island, New Siberian Islands (Vangengeim 1961) and early Wisconsin deposits (Iedoma Suite) of the Kolyma Lowland (Sher 1971). Arctic fox specimens from late Pleistocene deposits near Fairbanks, Alaska are being described by R. Tedford and B. Taylor (personal communication 1976) of the American Museum of Natural History.

In the Yukon, the earliest arctic fox specimens are probably of Sangamon interglacial age (NMC 15863 from Old Crow Locality 44). Two fossils of late Wisconsin age are known from Hunker Creek in the Dawson Area. The Yukon fossils constitute the first arctic fox records from Pleistocene deposits in Canada.

Arctic foxes are circumpolar in distribution. Generally, they inhabit tundra and, as fossils, are good

cold climate indicators. However, sometimes these small foxes venture far south of their normal range into boreal forest areas; or they may move onto sea ice where they are known to follow polar bears and feed on the remains of their kills. Arctic fox populations usually undergo great fluctuations every three to five years. Crashes tend to follow crashes in lemming populations. Lemmings and other arctic voles are the main diet of the arctic fox. It also feeds on arctic hares, ground squirrels, ptarmigan, young birds and bird eggs (Banfield 1974, pp. 295-298).

Vulpes vulpes (red fox)

Referred specimen

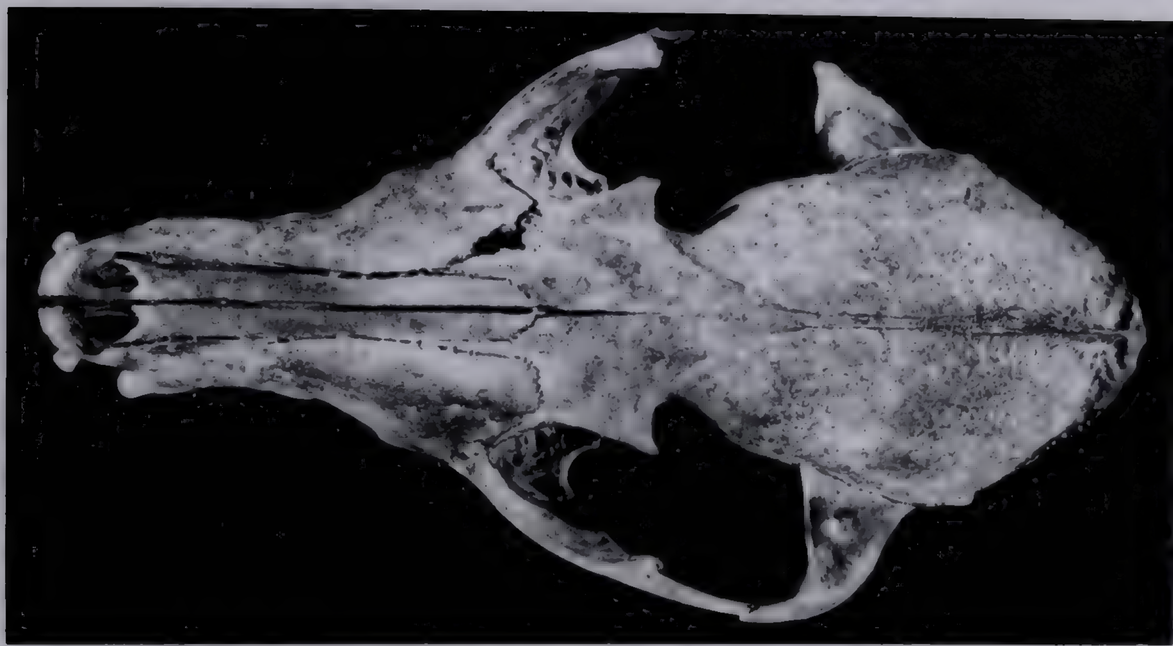
A single specimen consisting of a nearly complete cranium (NMC 28359; Figure 31A-C , Table 30) was collected on the surface at Locality 115 on the Old Crow River. The bone is stained deep brown, but the teeth, although they have a yellowish cast, look very fresh. All teeth are present and in good condition except for I^1s, I^2s, RC^1, P^1s and LP^3. The central part of the right zygomatic arch is missing.

A key to separating the red fox from the arctic fox *(Alopex lagopus)* on the basis of cranial measurements

Figure 31. Cranium (NMC 28359, Old Crow River Locality 115) of a Pleistocene red fox *(Vulpes vulpes)*. A. Dorsal view.

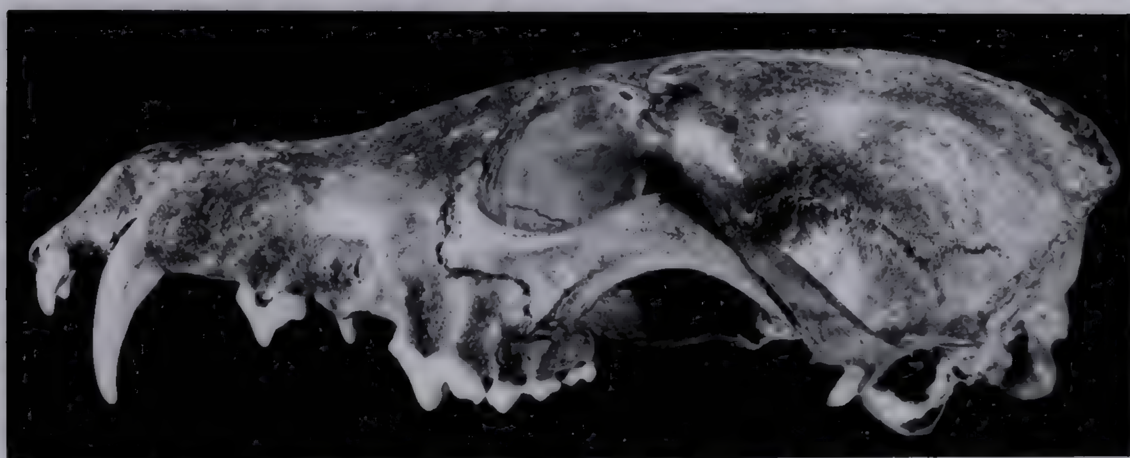
B. Left lateral view.

C. Ventral view.



A

5 CM



B

5 CM

C

5 CM

Table 30. Measurements of a Pleistocene red fox *(Vulpes vulpes)* cranium from the Yukon Territory compared to crania of Recent red foxes and arctic foxes *(Alopex logopus)* from northern North America.

SPECIMENS	SEX	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
		MEASUREMENTS (mm) *																		
Vulpes vulpes. Pleistocene, Y.T.																				
NMC 28359 Old Crow Loc. 115	-	150.0	77.6	66.5	85.0e	46.7	17.8	30.4	23.2	10.6	3.6	11.2	3.9	17.3	7.5	10.9	13.7	5.5	8.1	70.2
Vulpes vulpes. Recent																				
NMC 31073 Y.T.	♂	156.0	75.6	68.4	80.3	43.8	16.9	29.2	21.7	10.8	3.8	11.4	4.2	17.2	7.8	10.4	12.4	5.7	7.6	71.4
NMC 31729 Y.T.	♂	150.8	75.2	65.4	81.4	43.4	15.7	28.3	23.9	9.7	3.4	10.9	3.8	15.8	7.2	9.9	12.1	5.9	8.8	68.6
NMC 17956 Y.T.	-	147.9	75.5	62.9	76.9	43.4	16.0	27.9	24.3	9.4	3.6	10.5	3.8	15.9	6.6	10.0	11.5	5.8	8.0	67.4
NMC 17955 Y.T.	-	142.9	72.9	67.6	72.4	39.8	14.4	26.9	24.7	9.0	3.2	10.6	3.8	15.8	6.9	9.7	11.2	5.3	7.2	66.0
NMC 18132 Y.T.	♀	141.8	73.9	60.7	75.8	42.6	15.0	29.2	24.8	10.0	3.4	10.5	3.8	15.8	7.9	9.8	11.3	5.2	7.8	64.3
NMC 2434 Alaska	♂	138.7	69.2	61.1	78.5	43.0	13.7	30.3	24.2	9.9	3.5	10.3	3.6	15.4	7.1	10.5	11.9	5.6	8.7	63.4
Alopex lagopus. Recent																				
NMC 21309 N.W.T.	♂	124.1	59.3	54.4	65.3	38.2	16.3	27.3	25.9	8.3	3.5	9.2	3.7	13.2	7.3	8.8	11.2	4.7	7.3	57.7
NMC 21303 N.W.T.	♂	123.2	58.3	54.4	71.5	40.6	18.4	29.3	25.4	8.2	4.0	9.1	4.2	14.3	7.2	8.7	10.4	4.9	7.4	55.5
NMC 21307 N.W.T.	♀	120.5	58.5	52.8	68.1	39.4	16.4	26.7	22.9	8.2	3.5	9.0	3.7	14.3	7.0	8.5	10.3	4.8	6.8	55.9
NMC 21308 N.W.T.	♂	119.2	57.0	52.8	69.8	40.0	16.0	27.8	24.1	7.3	3.4	8.9	3.6	14.1	6.4	8.4	10.3	4.4	6.7	53.5
NMC 21305 N.W.T.	♂	117.8	55.5	51.9	68.1	40.1	15.9	26.5	22.9	8.0	3.6	8.9	3.7	13.8	6.9	8.7	10.2	4.4	7.0	55.0
NMC 21319 N.W.T.	♀	116.3	54.4	52.9	66.9	38.0	15.2	22.0	24.5	7.8	3.6	8.1	3.6	13.0	6.6	8.5	10.1	4.9	6.6	52.0

* 1. Condylobasal length. 2. Palatal length. 3. Postpalatal length. 4. Zygomatic breadth. 5. Width across outer faces of M^1s. 6. Palatal width inside P^2s. 7. Interorbital width. 8. Width at postorbital constriction. 9. Length P^2. 10. Width P^2. 11. Length P^3. 12. Width P^3. 13. Length P^4. 14. Width P^4. 15. Length M^1. 16. Width M^1. 17. Length M^2. 18. Width M^2. 19. Alveolar length (C^1-M^2).

is that in the former, the rostral width measured at P^2 is less than 18% of the condylobasal length (Youngman 1975, p. 124). In this case, the percentage is 16.6, indicating that NMC 28359 is referable to *Vulpes vulpes*. Also, as Kurtén (1966, p. 5) has pointed out, the infraorbital foramina in the red fox (and this specimen) are situated directly above the posterior roots of the P^3s, while in the arctic fox they are situated farther back, above and between the P^3s and P^4s.

The Old Crow specimen is larger than most Recent red fox specimens from the Yukon and Alaska with which it was compared. Only a male cranium from the Yukon (NMC 31073) approaches the fossil in size. The fossil is much larger in most measurements (e.g. condylobasal length and carnassial length) than Recent crania of arctic foxes from the Northwest Territories with which it was compared.

Discussion

The red fox may have evolved in Eurasia from *Vulpes alopecoides* of Villafranchian age. Its earliest European representatives occurred in the Holstein (= ?Yarmouth) interglacial and were of small size. The species probably entered North America during the Illinoian glaciation, for the oldest fossils there are

from deposits of that age (e.g. Conard Fissure, Arkansas) (Kurtén 1968, p. 116). Both the red fox and arctic fox have been recorded from early Wisconsin deposits (Iedoma suite) in the Kolyma Lowland of northeastern Siberia (Sher 1971).

In Canada, remains of the red fox have been reported from Sangamon interglacial deposits at Medicine Hat, Alberta (Stalker and Churcher 1970) and from postglacial deposits estimated to be 5,000 to 6,000 years old near Hamilton, Ontario (Wetmore 1958, Churcher and Karrow 1963). The specimen from the Old Crow Basin appears to be of late Pleistocene age. Nothing more specific can be said.

Late Pleistocene sites where *Vulpes vulpes* has been recorded are rare in the United States. It is known from the Fairbanks area of Alaska (Péwé 1975a, p. 97), Burnet Cave and Isleta Caves, New Mexico, Ventana Cave, Arizona, and Little Box Elder Cave, Wyoming (Anderson 1968, p. 27).

The red fox is found throughout North America in a variety of habitats ranging from tundra to forests and from dry uplands to swamps. It prefers partly open country. An interesting feature of its distribution in

the present interglacial is that, since the early 1900's, red foxes have dispersed rapidly northward as far as Ellesmere Island (Macpherson 1964). Red foxes are omnivorous. Their main diet consists of rodents and hares, but they also feed on birds, fishes, other small animals and plants.

Cuon sp. (dhole)

A single specimen of the dhole (Figure 32A-C, Table 31) has been recovered from Yukon Pleistocene deposits. Fragmentary postcranial specimens from the Old Crow Basin that are intermediate in size between coyote and wolf may in part represent the dhole, but they are not described.

Referred specimen

NMC 14353 from Old Crow Locality 14N is a right mandible fragment with RP_4, the socket for part of the anterior root of RM_1, the alveolus for RP_3, the alveolus for RP_2 lacking part of the socket for the anterior root, and the posterior part of the socket for RP_1. RP_4 is virtually unworn and does not differ from RP_4s in two Recent Chinese *Cuon* specimens (AMNH 54984 and 43144) except that it is slightly larger - and there is a good deal of variation in the size of that genus. The RP_4 has a small but clear anterointernal cusplet, which is also

Figure 32. Right mandibular fragment with RP_4 (NMC 14353, Old Crow Locality 14N) of a Pleistocene dhole (*Cuon* sp.).

A. Lateral view.

B. Occlusal view.

C. Medial view.

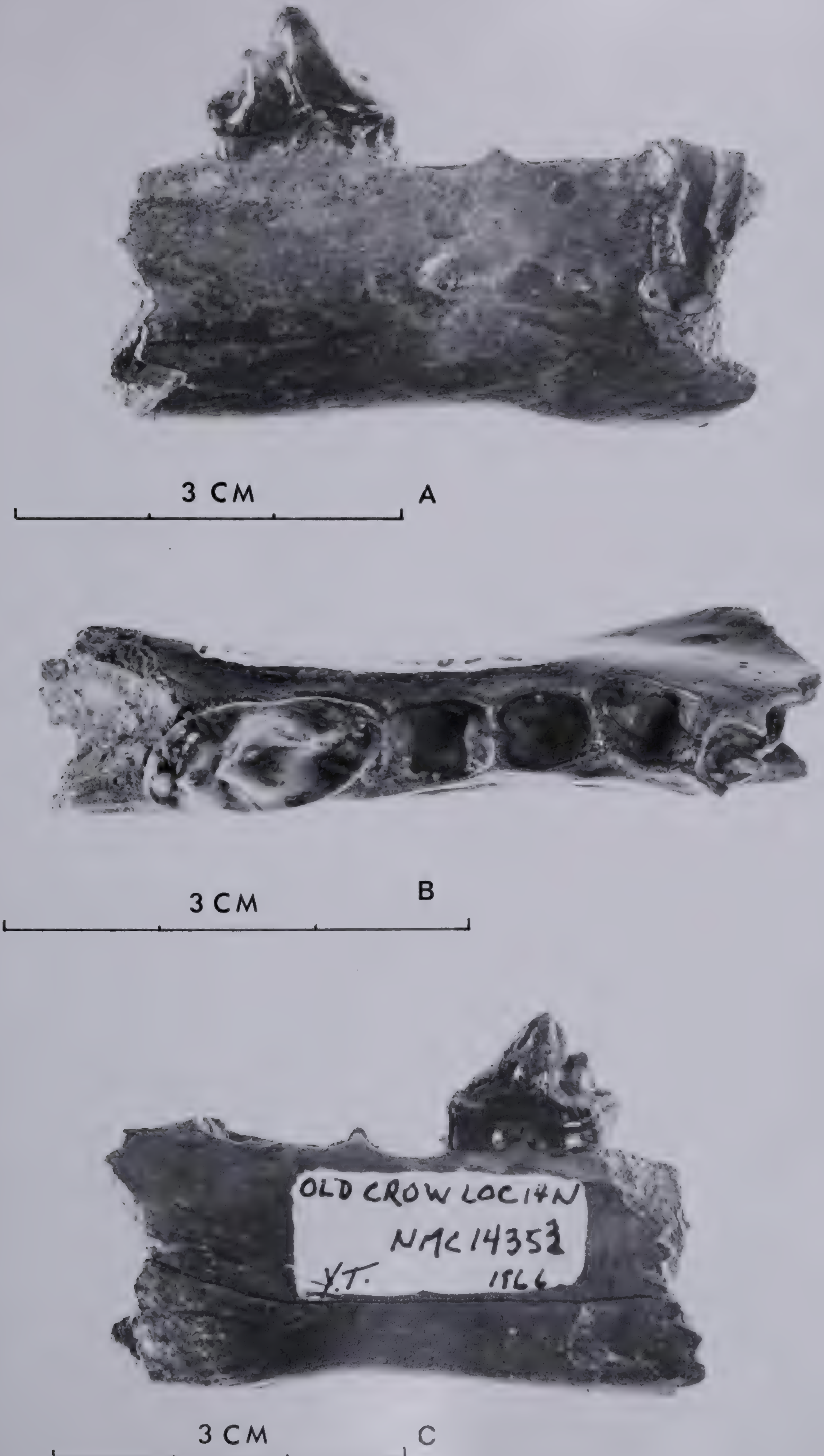

3 CM
A
3 CM
B
OLD CROW LOC14N
NMC14353
Y.T.
1966
3 CM
C

Table 31. Measurements of a Pleistocene dhole (*Cuon* sp.) mandible from the Yukon Territory compared to mandibles of Recent dholes from China.

Specimens	Sex	Measurements (mm)*																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17***	18***	19	20	21
Cuon sp. Pleistocene, Y.T.																						
NMC 14353 Old Crow Loc. 14N	-	21.0**	12.0**	19.0**	9.0**	-	-	-	-	-	-	15.0	6.9	-	-	-	-	-	-	-	-	-
Cuon sp. Recent, China																						
AMNH 54984 Yunan Province	♂	23.9	11.2	20.7	10.2	5.3	3.5	8.6	4.8	9.8	4.8	12.6	6.3	20.2	7.9	6.7	5.6	-	-	37.7	27.1	63.9
AMNH 43144 Yunan Province	♂	22.2	10.2	20.6	9.0	4.6	3.3	7.2	4.8	9.6	4.7	11.6	6.0	20.7	7.9	6.0	5.9	-	-	35.6	27.9	62.7

*1 - Mandible depth below centre of M_1.
2 - Mandible width below centre of M_1.
3 - Mandible depth below point between P_3 and P_4
4 - Mandible width below point between P_3 and P_4
5 - Length P_1
6 - Width P_1
7 - Length P_2
8 - Width P_2
9 - Length P_3
10 - Width P_3
11 - Length P_4
12 - Width P_4
13 - Length M_1
14 - Width M_1
15 - Length M_2
16 - Width M_2
17 - Length M_3
18 - Width M_3
19 - Alveolar length P_1-P_4
20 - Alveolar length M_1-M_2.
21 - Alveolar length P_1-M_2.

** Approximate.

*** M_3 not present in *Cuon*.

observable in the Chinese specimens. The nearly straight, rather crowded tooth row of NMC 14353 is characteristic of the dhole mandible (B. Lawrence, personal communication 1975). A slight departure from straightness results from the outward turning of the anterior part of RP_2, but this appears to be a function of its being crowded between RP_3 and RP_1, which are in direct line with RP_4. The mandible, like that of the coyote *(Canis latrans)*, is narrower mediolaterally than in the wolf *(Canis lupus)*, but in this fossil and in Recent *Cuon* examined it is flatter and deeper than in the coyote. The jaw thickens toward the symphysis, but not enough of this diagnostically valuable region is preserved to securely distinguish the fossil from canids other than the dhole. Important features of NMC 14353 seen in comparative specimens and figures (e.g. Novikov 1962, p. 88) of *Cuon* are the pronounced concavity of the inferior profile of the jaw below P_3, and the series of three mental foramina - the largest below the anterior root of P_2 and smaller ones below the anterior and posterior roots of P_3. The latter feature is observable in AMNH 54984, but is somewhat variable, for only two foramina are present in another mandible of the same species (AMNH 43144).

I am grateful to R.H. Tedford (personal

communication, 1970) for examining the original specimen and confirming my preliminary identification of NMC 14353 as *Cuon*. In comparing the Yukon fossil with Recent Asian and Pleistocene specimens of *Cuon* in collections of the American Museum of Natural History, he suggested that it appeared to be closest to *Cuon javanicus*. However, as the specimen is relatively incomplete it seems best to refer it to *Cuon* sp., until better material becomes available.

Discussion

The fossil is stained black, suggesting a pre-late Wisconsin age. I suspect that a fossil from Alaska is also referable to *Cuon*. It is a mandible (F:AM 67180) collected by Otto Geist from Illinoian sediments at Cripple Creek near Fairbanks. The specimen was later identified by M.C. McKenna as *Xenocyon* (Péwé and Hopkins 1968, p. 269). I follow Romer (1966, p. 384) and Gromova (1968, p. 32) in considering *Xenocyon* a junior synonym of *Cuon*. These two specimens are the first records of the dhole from America.

In Siberia, *Cuon* is known from ?late Pleistocene deposits in the Lower Udin Caves (Gromova 1968, p. 269), but it has not been reported in any of the major Pleistocene vertebrate faunas of northeastern Siberia.

The true dhole, resembling *Cuon alpinus priscus*, has been found as early as Mindel (?Kansan) time in China (Choukoutien) (Kurtén 1968, p. 114).

Both dhole and the hunting dog *(Lycaon)* are closely related to *Canis*, probably diverging from that stock as late as the Astian (late Pliocene). The general trend in the evolution of the dhole is a reduction in the number of tooth cusps and an increase in trenchancy of those remaining. The most primitive species, *Cuon majori* of the late Villafranchian of Europe and China, was characterized by slightly smaller, sharper teeth than in *Canis*. By Waalian (?Nebraskan) or Cromer (?Aftonian) interglacial time *Cuon* had lost M_3, as demonstrated in fossils of the very large *C. majori stehlini*. *Cuon alpinus* first appeared in Germany during the late Günz (?late Nebraskan), and M_2 changed from a three-cusped condition to a trenchant single-cusped tooth between that time and the late Pleistocene, as exemplified by fossils of the large, wolf-sized *C. alpinus europaeus* (Kurtén 1968, p. 113). In Europe the dhole has been reported from Czechoslovakia, Hungary, Austria, Switzerland and Monaco during the late Pleistocene. It became extinct there at the close of the Würm (Wisconsin) glaciation.

Evidently *Cuon* originated from ancestral *Canis* stock in Eurasia during the late Pliocene and had reached North America by Illinoian time as indicated by the mandible from near Fairbanks, Alaska. Probably its ability to survive in cool alpine and steppe conditions enabled it to move across the Bering Isthmus in pursuit of game during the late Pleistocene.

The dhole looks like a small, rust-colored wolf. It has relatively long slender legs, a short muzzle, erect ears with rounded tips and a very furry tail. Presently it is found from southern Siberia to Malaya, Sumatra and Java, and it seems to prefer alpine forest regions. In some cases it is found above the treeline. It hunts in packs, preying on goats, sheep and deer (Stroganov 1969, p. 79). Dholes are occasionally trapped by man. As can be seen by its dentition, the dhole is more exclusively carnivorous than most canids (Kurtén 1968, p. 114).

Family Ursidae

Arctodus simus yukonensis
(Yukon short-faced bear)

Several cranial and postcranial specimens (Figures 33A-C, 34A-C, 35A, Table 32) are referred to this

Figure 33. Cranium (NMC 7438, Dawson Locality 31) of a Pleistocene Yukon short-faced bear *(Arctodus simus yukonensis)*. A. Dorsal view. Note damage to upper part of cranium.

B. Right lateral view.

C. Ventral view.


5 CM
A
5 CM
B
5 CM
C

Figure 34. A. Lateral view of a left facial fragment with LP^3-LM^2 (NMC 24650, Old Crow Locality 11A) of a Pleistocene Yukon short-faced bear *(Arctodus simus yukonensis).*

B. Ventral view of NMC 24650 showing occlusal surfaces of teeth.

C. Restoration of a Yukon short-faced bear *(Arctodus simus yukonensis)* attacking a large-horned bison *(Bison crassicornis).* Ink sketch by Bonnie Dalzell.


A
3 CM
B
C

Table 32. Measurements of Pleistocene Yukon short-faced bear *(Arctodus simus yukonensis)* crania from the Yukon Territory compared to those of Yukon short-faced bears from Alaska, Nebraska and California.

Specimens	Measurements (mm)*																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Arctodus simus yukonensis, Pleistocene, N. America																	
NMC 7438 Dawson Loc. 31, Y.T.	440	463	521	260	364	135	152	205	105	26.0	22.5	17.0	27.0	25.0	37.5	25.0	22.0
NMC 24650 Old Crow Loc. 11A, Y.T.	-	-	-	-	-	-	-	-	-	-	20.0	15.0	23.2	19.8	35.1	20.8	17.5
NMC 19006 Old Crow Loc. 66, Y.T.	-	-	-	-	-	-	-	-	-	-	21.6	16.8	25.2	22.8	37.4	23.6	19.8
F:AM 30492 Upper Cleary Ck., Alaska**	416	444	496	249	354	136	141	194	107	25.1	24.6	16.8	27.7	27.3	40.8	25.8	23.7
F:AM A-386-1075 Ester Ck., Alaska**	416	438	480	240	-	124	141	177	94	22.1	22.3	15.4	26.6	25.1	37.7	24.2	23.0
F:AM 25531 Hay Springs, Nebraska**	413	436	490	236	-	125	-	184	-	21.0	23.4	18.9	28.3	26.1	41.4	25.8	21.7
UC 40086 Irvington, California**	-	-	470?	-	-	122	124	-	87	23.3	23.9	18.0	-	-	-	-	-

* 1 - Basal length
2 - Condylobasal length
3 - Maximum length
4 - Palatal length
5 - Zygomatic width
6 - Rostral width at canines
7 - Width over M^2
8 - Width over postorbital processes
9 - Width of nasal opening
10 - C^1 width
11 - P^4 length
12 - P^4 width
13 - M^1 length
14 - M^1 width
15 - M^2 length
16 - M^2 anterior width
17 - M^2 central width

** Measurements from Kurtén (1967).

subspecies. They come from Pleistocene deposits in the Dawson and Old Crow areas. The large size of the fossils, in addition to other characteristics, allow them to be readily distinguished from black *(Ursus americanus)*, brown *(Ursus arctos)* and polar *(Ursus maritimus)* bears.

Referred specimens

While digging for gold on fractional claim 57a on Gold Run Creek (Dawson Locality 31), J.S. Perron found most of a bear cranium at a depth of 40 feet (12.2 m) in frozen ground. The specimen was sold to P.F.X. Genest of Ottawa, who in turn sold it to the Geological Survey of Canada (Harington and Clulow 1973, p. 699). It later became part of the collections of the National Museums of Canada.

Lambe (1911a) first referred to the specimen as *Arctotherium* cf. *simum*, and later (Lambe 1911b) described it as the type of a new species of short-faced bear *Arctotherium yukonense*, which he considered to be most closely allied to *A. simum* Cope. Kurtén (1967, p. 57) recognized a subspecific difference between the very large forms from the Yukon, Alaska, California (Irvington), and Nebraska (Hay Springs), and the remaining forms. He named the former *Arctodus simus yukonensis* and the latter *A. s. californicus*.

The cranium (NMC 7438) is in good condition except for damage to the upper anterior portion. The nasals and the greater part of the frontals are lacking. On the left side LI^2 and premolars anterior to LP^4 are missing, as are the three incisors, and the premolars anterior to RP^4 and RM^2 on the right side. The size of the skull, the large canines, the well-developed sagittal crest and the heavy tooth wear suggest that an old male is represented. The great zygomatic breadth of the cranium is remarkable; it is nearly 70% of the length of the skull. The upper part of the occiput considerably overhangs the occipital condyles. Perhaps Lambe (1911b, p. 22) was incorrect in interpreting the three alveoli between the canines and P^4s as sockets for P^1 and a double-rooted P^3. As Merriam and Stock (1925, p. 12) have noted, the three anterior premolars are single-rooted, so probably the alveoli referred to by Lambe are actually for P^1, P^2 and P^3. Table 32 shows the relatively large size of NMC 7438: apparently it exceeds all other skulls of *A. simus* (Kurtén 1967, p. 8). It is difficult to determine the original color of the skull for it was covered with dark shellac. Probably it is of late Pleistocene age.

NMC 24650 from Old Crow Locality 11A is a left

facial fragment with LP^3-LM^2, and partial sockets for LI^1-LI^3, LC^1, LP^1 and LP^2. The premaxilla is well fused to the maxilla. The clearly exposed socket for LC^1 shows that the root was approximately 36 mm in anteroposterior diameter and 70 mm long. The lateral face of the paracone of LP^4 has been broken off. The paracone and metacone of LM^1 are moderately worn, and there is slight wear on the paracone of LM^2, suggesting that the bear was mature. The teeth are brownish green while the facial bone is blackish brown.

NMC 19006 from Old Crow Locality 66 is a fragmentary right maxilla containing RP^4-RM^2. RP^4 is virtually unworn, while the paracone and metacone of RM^1 are less worn than those of NMC 24560. Staining is similar to the previous specimen, except that the teeth are blacker.

Two complete canines are in the collection. NMC 15266 from Old Crow Locality 22 appears to be LC^1. The tip is blunt and a large wear facet is developed on the medial surface where occlusion occurred with LC_1. Part of the cementum has been stripped from the anterior of the root, exposing a series of what may be annular growth rings. An attempt will be made to section these

canines in order to learn about the life span of these extinct bears. Maximum dimensions of the tooth are 34.7 mm long x 24.2 mm wide. NMC 21057 from between Old Crow Localities 14 and 14N may be RC^1. It is worn at the tip and is partly split lengthwise. Its maximum dimensions are 31.5 mm long x 20.7 mm wide. The former tooth is stained reddish brown, the latter dark brown.

NMC 21091 from Old Crow Locality 14 is the anterior part of a mandible with LC_1 and alveoli for most of the incisors, RC_1, LP_1 and LP_4-LM_2. The canine is very heavily worn and polished. LP_2 and LP_3 are absent in this fossil, which evidently represents an old individual. Three mental foramina typical of *Arctodus* are seen from a lateral view below the alveolar margin of LC_1, below the "diastema" between LP_1 and LP_4, and below the anterior root of LP_4. Minimum depth of the mandible below the diastema is approximately 55 mm, which is comparable to *Arctodus simus* specimens UC 3001 and 3003 from Potter Creek, California (Kurtén 1967, p. 27). The mandibular bone is dark brown, the canine being stained reddish black.

A few of the more complete postcranial elements will be mentioned. NMC 28299 from Old Crow Locality 136

is an axis vertebra lacking the transverse processes. Maximum width across the articular surface for the atlas is 77.8 mm; greatest width across the postzygapophyses is 57.1 mm; the neural spine is slightly more than 92 mm long; and the greatest length of the centrum is 81.9 mm.

NMC 27831 from Old Crow Locality 67 is the distal end of a right humerus. The outer bar enclosing the entepicondylar foramen is missing in part. Its maximum distal width is 115.8 mm, and its maximum width across the distal articular surface is 83.6 mm. These measurements are relatively small compared to other *A. simus* humeri from California Pleistocene deposits (Kurtén 1967, p. 31). NMC 26864 from Old Crow Locality 22 is a left radius lacking the distal epiphysis. The total length of this bone is 410$^+$ mm, which makes it markedly longer than complete radii of *A. simus* from Potter Creek Cave, California (UC 10262 and 3427 are 374.5 mm and 389.3 mm long respectively). Maximum proximal diameter is 68.2 mm; midshaft width is 37.0 mm; midshaft depth is 23.1 mm; and the maximum distal width is 77.9 mm. This bone indicates that *Arctodus simus yukonensis* was a very long-legged bear. Kurtén (1967, p. 47) has remarked on this feature of *A. simus* previously. NMC 27581 from Old Crow Locality 66 is the proximal half of another left radius, which is more

massive than NMC 26864: probably it was larger all over than that specimen. The part preserved is 214.8^+ mm long; maximum proximal diameter is 66.6^+ mm (the articular margins are heavily eroded); midshaft width is 42.4 mm; and midshaft depth is 27.7 mm. NMC 27295 from Old Crow Locality 29 is a left calcaneum measuring 114.1 mm in total length, 70.6 mm in maximum width, and 40.2 mm in width of the cuboid facet. These measurements are small compared to those of a series from California measured by Merriam and Stock (1925, p. 31).

Discussion

Most fossils of the Yukon short-faced bear are very darkly stained, suggesting a pre- late Wisconsin age. Likely these bears reached Eastern Beringia, the northernmost part of their range, during an interglacial - perhaps the last (Sangamon) interglacial. Yet no fossils of this animal have been excavated from deposits (e.g. Old Crow Locality 44) that appear to be of Sangamon age. A cranium (NMC 9438) from the Dawson Area may be of late Wisconsin age. The only other Canadian record of *Arctodus simus* is a mandible fragment with M_3 from what appear to be outwash deposits laid down at the close of the Sangamon interglacial near Fort Qu'Appelle, Saskatchewan (Harington 1973, p. 14).

Two very large skulls of the Yukon short-faced bear are known from Ester and Upper Cleary creeks in the Fairbanks area of Alaska. They are probably of late Pleistocene age (Kurtén 1967, p. 8).

Arctodus belongs to the Tremarctinae; the other two subfamilies of bears being the Agriotheriinae and the Ursinae. *Ursavus*, which lived from early to middle Miocene time, probably gave rise to the two living bear subfamilies. Of these, the Tremarctinae are known only from America, the earliest representative of the group being *Plionarctos* of late Pliocene age. Likely this genus is ancestral to the spectacled bear, *Tremarctos*, and the short-faced bear, *Arctodus*. The early history of *Arctodus* is poorly known, but it seems to have become widespread in North America about Kansan time (e.g. Rock Creek, Texas; Irvington, California; Port Kennedy Cave, Pennsylvania; and possibly Fossil Lake, Oregon and Hay Springs, Nebraska). Three species of Pleistocene South American short-faced bears are recognized: *Arctodus (Arctotherium) bonariensis*, the largest; *Arctodus (Arctotherium) pamparus*, from Argentina; and *Arctodus brasiliensis*, the smallest *Arctodus* known - which may lie near the ancestor which gave rise to the Nearctic and Neotropical branches of

of the genus.

Of the two North American species, *Arctodus pristinus*, a rather lightly built bear with small teeth and slender limb bones, appears to be the more primitive and occupied territory near the Atlantic coast. *Arctodus simus* is characterized by a shorter face, longer teeth and larger, more powerful limbs. Its remains have been found almost exclusively west of the Mississippi River. It ranged from Alaska to Mexico. Northern populations of *A. simus* seem to have been the largest in size. A distribution map of *Arctodus* localities in North America (Harington 1973, Figure 2) indicates that *A. simus* occupied higher, well-drained grasslands, whereas *A. pristinus* preferred more heavily wooded Atlantic coastal regions. *A. simus* became extinct toward the close of the Wisconsin glaciation some 10,000 years ago, perhaps partly because of the earlier extinction of some of its large herbivorous prey, and partly because of increased competition with brown bears *(Ursus arctos)*, which seem to have entered North America from Eurasia during the Illinoian glaciation. Remains of brown and short-faced bears have been found together in late Wisconsin deposits of Little Box Elder Cave in Wyoming (Kurtén and Anderson 1974, p. 3).

The spectacled bear *Tremarctos ornatus* of South America is the closest living relative of *Arctodus*.

Kurtén (1967, p. 50) considers *A. simus* to have been a predominantly carnivorous species, and by far the most powerful land predator in the Pleistocene of North America. It may have preyed on large herbivores, such as bison, deer, horses, and ground sloths. Certainly bison and mammoths were among its contemporaries in both southern Saskatchewan and the Yukon - Alaska region during the late Pleistocene.

Ursus cf. *americanus* (American black bear)

Referred specimen

A single specimen (Table 33) from the Old Crow Basin Pleistocene deposits is tentatively referred to the black bear. NMC 16425 from Old Crow Locality 57 is a complete right scapholunar. It is similar in size and morphological features to the same element from a Recent black bear (NMC 7061). The fossil is smaller than a scapholunar of a Recent brown bear from the Northwest Territories, and is stained dark brown.

Table 33. Measurements of a Pleistocene black bear (*Ursus* cf. *americanus*) scapholunar compared to that of a Recent black bear, Recent brown bear (*Ursus arctos*) and Pleistocene short-faced bears (*Arctodus* sp.)

Specimens	Measurements (mm)*	
	1	2
Ursus cf. *americanus*.Pleistocene, Y.T.		
NMC 16425 Old Crow Loc. 57	40.5	38.0
Ursus americanus.Recent, Quebec		
NMC 7061	37.4	35.3
Ursus arctos.Recent, N.W.T.		
NMC 2772	46.4	46.5
Arctodus sp. Pleistocene, California (Merriam and Stock 1925, P. 26)		
UC 5975	56.3	56.0
UC 24253	71.6	71.8

* 1 - Maximum length.
2 - Maximum width.

Discussion

The Yukon specimen appears to be of pre- late Wisconsin age. The only other report of this species of relatively great age in Canada is in the Acasta Lake fauna from the Northwest Territories, which is approximately 7,000 years old according to radiocarbon dates (Harington 1976 MS. p. 53). *Ursus* sp. is reported from Illinoian deposits near Fairbanks, but there are no definite records of the black bear in the Pleistocene of Alaska. The earliest specimens from North America appear to be of Kansan age. They were found in Port Kennedy Cave, Pennsylvania. However, the possibility exists, if Bjork's (1970, p. 17) ideas are correct, that an ursine bear that he describes as *Ursus abstrusus*, closely related to *Ursus boeckhi* of Eurasia, entered North America during the Pliocene and either became extinct or gave rise to *Ursus americanus* independent of Eurasian bears of the subgenus *Euarctos*. Admitting that the evidence is slim, I prefer the former explanation, which implies a secondary migration of bears of the subgenus *Euarctos* from Asia to North America about Kansan time.

Ursus americanus apparently has affinities with the living Asiatic black bear *(Ursus thibetanus)* and the extinct *Ursus etruscus*, which evidently gave rise to the brown, polar and cave bears. Erdbrink (1953, p. 316) makes the interesting

remark that an attempt at a reconstruction of the Etruscan bear would be aided by considering the external appearance, size and general habits of the American black bear. Kurtén (1968, p. 129) agrees, stating: "This species might almost be regarded as a surviving slightly modified Etruscan bear....".

Ursus thibetanus has not been identified from Pleistocene deposits of northeastern Siberia. However, to the south, specimens of late Villafranchian age in China are transitional between *U. etruscus* and *U. thibetanus.* The latter species seems to have been predominantly Asiatic in distribution, occurring in China from the middle to late Pleistocene. By the Cromer (?Aftonian) interglacial it had spread to central Europe (the European black bear is sometimes regarded as a distinct species, *U. mediterraneus*).

In summary, it is clear that the Asiatic black bear *(U. thibetanus)* evolved from the Etruscan bear *(U. etruscus)* during the late Villafranchian in eastern Asia. It had reached central Europe by the ?Aftonian interglacial and, as an ancestor of the American black bear, had spread to eastern North America by Kansan time, suggesting a crossing of the Bering Isthmus during the Kansan glaciation. This early form of the American

black bear was still very similar to its ancestor, the Asiatic black bear (Kurtén 1968, p. 129).

Ursus americanus is confined to North America, ranging from the plateau of Mexico northward to the tree line. It is found throughout the Yukon Territory. These bears are relatively small, lacking the "dished" face of the brown bear, and displaying a variety of pelt colors. They prefer coniferous or deciduous forests as habitats, and are often found near marshes and berry patches. Generally, they occupy winter dens from October to April. They are omnivorous and opportunistic feeders, rather like the brown bears, but concentrating more on plant food. About three-quarters of their diet is vegetable matter (Banfield 1974, p. 306). Men and brown bears sometimes prey on black bears.

Ursus arctos (brown bear)

In this discussion, I refer to any member of the species *Ursus arctos* as a brown bear. The modern North American subspecies, *Ursus arctos horribilis* and *Ursus arctos middendorffi*, are referred to as the grizzly bear and Kodiak bear, respectively. Because of their general incompleteness and scarcity, the Yukon fossils are referred to *Ursus arctos*, rather than either of the living subspecies.

Brown bear fossils (Figure 35B-C, Tables 34-35) are rarely collected from Pleistocene deposits in the Yukon Territory. Three specimens are from the Old Crow Basin, and one is from the Dawson Area. The fossil mandibles are much larger in every respect than those of the black bear (*Ursus americanus*) and smaller than those of Kodiak bears (*Ursus arctos middendorffi*) seen. The mandibles are most like those of the grizzly bear (*Ursus arctos horribilis*), but because the teeth and other important features are missing, the fossils are referred to *Ursus arctos*.

Referred specimens

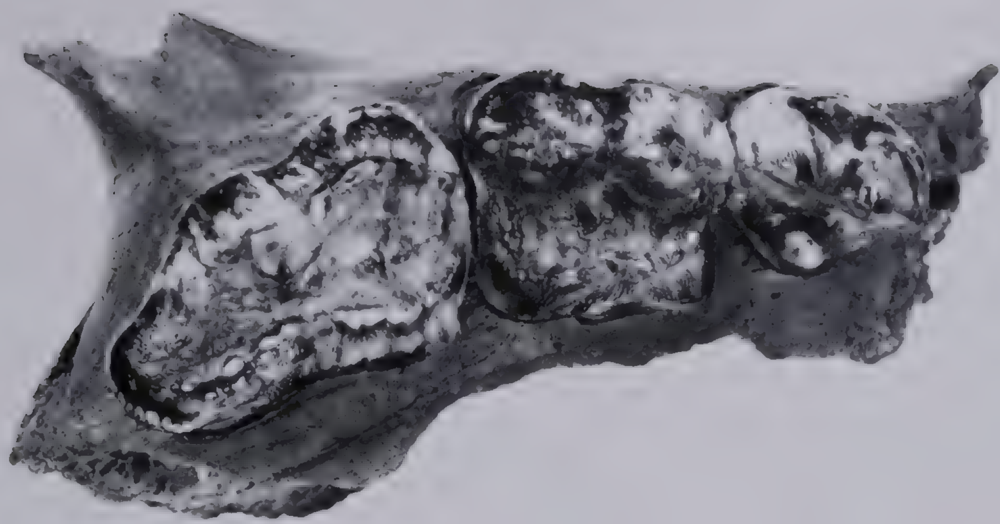
NMC 25141 from Old Crow Locality 12 is a left mandible lacking teeth, which is badly damaged near the canine socket. The posterior two-thirds of the ascending ramus is missing. In addition to the partial socket for LC_1, alveoli for LP_4-LM_3 are present. Four anterior mental foramina are situated approximately half way up the mandible. The two anterior ones are relatively large and situated below the diastema. The third is small and is below the anterior root of LP_4, while the fourth lies beneath the posterior root of LP_4. The specimen is stained blackish brown.

NMC 17388 from Old Crow Locality 20 is the anterior part of a left mandible containing the diastema and socket for LC_1. Three small indentations, which are interpreted as vestigial alveoli for LP_1-LP_3, are seen on the superior

Figure 35. A. Occlusal view of a right maxillary fragment with RP^4-RM^2 (NMC 19006, Old Crow Locality 66) of a Pleistocene Yukon short-faced bear *(Arctodus simus yukonensis)*.

B. Lateral view of a left mandible (NMC 25141, Old Crow Locality 12) of a Pleistocene brown bear *(Ursus arctos)*.

C. Anterior view of a right tibia (NMC 20386, Old Crow Locality 21) of a Pleistocene brown bear *(Ursus arctos)*.



A

3 CM

B

3 CM

C

3 CM

Table 34. Measurements of Pleistocene brown bear *(Ursus arctos)* mandibles from the Yukon Territory.

Specimens	Sex	Measurements (mm)*				
		1	2	3	4	5
Ursus arctos. Pleistocene, Y.T.						
NMC 25141 Old Crow Loc. 12	-	44.1	18.4	43.0	18.7	84.6
NMC 17388 Old Crow Loc. 20	-	37.6	17.2	-	-	-

*1 - Depth of mandible immediately anterior to P_4.

2 - Thickness of mandible immediately anterior to P_4.

3 - Depth of mandible at centre of M_2 taken on lateral side.

4 - Thickness of mandible at centre of M_2.

5 - Alveolar length P_4-M_3.

Table 35. Measurements of Pleistocene brown bear *(Ursus arctos)* tibiae from the Yukon Territory compared to those of Recent brown bears from Canada, a Recent black bear *(Ursus americanus)* from Quebec, and a Pleistocene short-faced bear *(Arctodus* sp.*)* from California.

Specimens	Measurements (mm)*						
	1	2	3	4	5	6	7
Ursus arctos.Pleistocene, Y.T.							
NMC 20386 Old Crow Loc. 21	265.7	72.5	51.2	21.9	26.7	57.0	33.9
NMC 29005 Dawson Loc. 17	-	-	-	-	-	61.8	34.8
Ursus arctos.Recent, Canada							
NMC 3983	266.1	70.4	49.2	21.1	28.3	55.2	30.6
NMC 3980	271.2	73.2	52.2	23.0	29.4	57.3	30.7
NMC 3979	260.7	70.6	53.9	21.2	32.7	50.7	30.7
NMC 3976	284.8	72.4	52.6	19.4	29.9	54.0	33.0
Ursus americanus.Quebec							
NMC 7061	249.3	67.8	48.9	20.2	22.4	48.8	25.7
Arctodus sp. California (Merriam and Stock 1925, p. 29)							
LAM Z31	404.0	110.7	-	40.7	41.6	88.4	52.0

*1 - Total length.
2 - Distal width.
3 - Distal depth.
4 - Midshaft width.
5 - Midshaft depth.
6 - Distal width.
7 - Distal depth.

surface of the diastema. A single large mental foramen lies below the centre of the diastema. R.H. Tedford assisted me in comparing NMC 17388 to specimens of the black bear *(Ursus americanus)*, spectacled bear *(Tremarctos ornatus)*, extinct short-faced bear *(Arctodus)* and grizzly bear *(Ursus arctos horribilis)* in the collections of the American Museum of Natural History. It is closest to the grizzly bear, and is referred to *Ursus arctos*, pending better evidence.
NMC 25141 and 17388 are alike in dimensions of the diastema and the fact that the mental foramina are highly situated on the mandible compared to those observed in recent *U. arctos*.

NMC 20386 from Old Crow Locality 21 is a complete right tibia. The crest is sharp and the medially trending ridges for muscle attachment are well marked. The lateral ridge, extending most of the length of the tibia on the posterior surface, is well developed as in other Recent brown bear tibiae to which it was compared. It is poorly developed in a specimen of *Ursus americanus* examined. The anterior margin of the medial malleolus of NMC 20386 forms a well developed ridge seen in other Recent brown bear tibiae, but not in a Recent black bear tibia. A slight swelling, perhaps pathological, occurs on the lower third of the medial side of the shaft of the fossil. A nutrient foramen is situated on the posterior upper quarter of the shaft, between the ridges marking the border of the flexor digitorum muscle. These foramina are quite variable in position in *U. arctos*. The fossil is stained reddish brown.

NMC 29005 from Dawson Locality 17 is distal third of a left tibia which is comparable in size to those of recent grizzly bears from Canada. It is light buff in color.

Discussion

The dark staining of the Old Crow specimens suggest that they are of pre- late Wisconsin age, while the tibial fragment from the Dawson Area is relatively fresh in appearance, suggesting a late Wisconsin age.

Specimens identified as *Ursus* sp. have been reported from Illinoian deposits at Cripple Creek Sump near Fairbanks, Alaska (Péwé 1975a, p. 96), but it is not certain that they represent the brown bear. *Ursus arctos* is definitely known from Wisconsin deposits near Fairbanks, and I (Harington 1976 MS. p. 75) have identified a brown bear mandible from Pleistocene sediments of the Ikpikpuk River on the Arctic Slope of Alaska.

Fossils from southeastern Canada are of greater immediate importance in estimating the time of migration of the brown bear from Eurasia to North America. Part of a mandible attributed to *U. arctos* was derived from Sangamon, or perhaps more likely, early Wisconsin sediments at Toronto, Ontario, and part of a left

humerus of *U. arctos* was collected from mid-Wisconsin deposits at nearby Woodbridge, which are estimated to be 40,000 to 50,000 years old (Churcher and Morgan 1975, p. 341). Grizzly bears also occupied Ontario during late Wisconsin time, for a well preserved skull with partial postcranial skeleton was found in beach deposits near Orillia. Radiocarbon analysis of a limb bone fragment associated with the skull yielded a date of 11,700 ± 250 years B.P. (Peterson 1965, p. 1233).

Evidence concerning the presence of grizzly bears east of their present range has been discussed by Harington *et al.* (1962) and Guilday (1968). In addition to the late Wisconsin specimen mentioned by Peterson, the skull of "*Ursus procerus*" from late Pleistocene (?Sangamon interglacial) gravels near Overpeck, Ohio is considered by Harington and Kurtén to represent *Ursus arctos* (Harington *et al.* 1962, p. 295; Guilday 1968, p. 248). The brown bear is also known from what are presumed to be postglacial deposits in Welch Cave, Kentucky (Guilday 1968, p. 248). The occurrence of brown bears in eastern North America during the late Pleistocene adds credence to persistent and evidently well-founded rumors of their survival until Recent times in the Ungava Peninsula (Elton 1954, p. 345; Harper 1961, pp. 104-110; Wright 1962, pp. 83-89).

Other records of *Ursus arctos* from southern North America are: two skulls of "Pleistocene" age from Lawton and Cheyenne, Oklahoma (Stovall and Johnston 1935); a skull of probable Pleistocene or possibly later age from Lenora, Oklahoma (Stovall 1936, p. 781); remains of late Wisconsin (approximately 10,370 years B.P.) age from Jaguar Cave, Idaho (Kurtén and Anderson 1972, p. 37); seven skull fragments, teeth and some postcranial material from late Wisconsin deposits at Little Box Elder Cave, Wyoming (Anderson 1968, p. 30); and a small skull from Rancho La Brea, California, considered by Kurtén (1960, p. 6) to be of postglacial age.

In northeastern Siberia, *Ursus* sp. is recorded from the Olyor Suite of Mindel (?Kansan) age. *Ursus arctos* first definitely occurs in the early Wisconsin Iedoma Suite of the Kolyma Lowland (Sher 1971). Remains of brown bears are relatively common in late Pleistocene to Recent sediments in caves in the karst region of southern Siberia (Ovodov 1970, p. 124).

The earliest brown bears are known from Mindel (?Kansan) deposits of Choukoutien, China. They were large and probably stemmed directly from the smaller Etruscan bear *(Ursus etruscus)*, which lived in southern Europe during

the Villafranchian. Brown bears continued to occupy eastern Asia from the early Pleistocene to the present, evidently entering Europe during the Holstein (?Yarmouth) interglacial and ultimately displacing the cave bear *(Ursus spelaeus)* there (Kurtén 1968, p. 127). Evidence considered previously indicates that brown bears first entered North America from Siberia during the late Illinoian glaciation, and that they had reached eastern North America by early Wisconsin, or possibly Sangamon time.

Brown bears are one of the largest carnivores living in the Holarctic region, some individuals being comparable in size to the largest polar bears *(Ursus maritimus)*. Human competition has forced the once widespread brown bears to withdraw to rather isolated mountainous or tundra areas in northwestern North America. They are found throughout the Yukon Territory. Closely related brown bears occur in a broad belt across Eurasia and in parts of Europe, where they are threatened by local extinction. Brown bears prefer open areas, as shown by their present distribution in alpine and arctic tundra, and subalpine forest of the Cordillera. They formerly occupied the Great Plains, and survivors of that population are sometimes encountered in the Swan Hills of Alberta.

In late autumn they seek caves or other shelters for the winter, sometimes excavating dens on hillsides. Denning generally lasts from November to April. Brown bears are omnivorous. They graze and scavenge; hunt moose, wapiti, mountain sheep and ground squirrels; and catch salmon in coastal streams. In summer they feed heavily on berries of various kinds. Humans are the main predator of this species, but occasionally brown bears kill people.

Family Mustelidae

Mustela erminea (ermine)

Referred specimens

Few ermine specimens (Figure 36A-D, Tables 36-37) have been collected from Pleistocene deposits in the Old Crow Basin. The best specimen consists of most of a left mandible with LP_3-LM_2 (NMC 28782) excavated from redeposited sands at Old Crow Locality 20. It is stained black, suggesting a pre- late Wisconsin age. The apex of the coronoid process seems to have been slightly eroded, which probably accounts for its lack of depth in the ascending ramus compared to a sample of Recent ermine from the Northwest Territories. Apart from a slightly deeper mandible, the specimen is closely comparable with Recent samples. Two Recent ermine mandibles from the Ural region of the Soviet Union (NMC 27544,

Figure 36. A. Lateral view of a left mandibular fragment with LP_3-LM_2 (NMC 28782, Old Crow Locality 20) of a Pleistocene ermine *(Mustela erminea)*.

B. Occlusal view of NMC 28782.

C. Medial view of a right ulna (NMC 25320, Old Crow Locality 27W) of a Pleistocene ermine *(Mustela erminea)*.

D. Anterior view of NMC 25320.


A
5 MM
B
C
5MM
D

Table 36. Measurements of Pleistocene ermine *(Mustela erminea)* mandibles from the Yukon Territory compared to those of Recent ermine from the Northwest Territories and the Soviet Union.

Specimens	Sex	Measurements (mm)* 1	2	3	4	5
Mustela erminea. Pleistocene, Y.T.						
NMC 28782 Old Crow Loc. 20	-	5.3	1.9	10.0	4.0	10.2+
NMC 25076 Old Crow Loc. 27W	-	5.8	-	-	4.2	-
Mustela erminea. Recent, N.W.T.						
NMC 21218	♂	5.2	1.9	10.4	3.6	10.7
NMC 21313	♀	5.2	2.0	10.3	3.7	10.5
NMC 21208	♀	5.2	1.9	10.3	3.6	10.8
NMC 21209	♂	5.3	1.9	10.2	3.7	10.5
NMC 21229	♂	5.3	1.8	10.4	3.5	10.9
NMC 21237	♂	5.4	1.8	10.6	3.7	10.4
Mustela erminea. Recent, U.S.S.R.						
NMC 27544	♂	5.8	2.0	11.4	4.4	12.4
NMC 27545	♂	5.7	2.0	11.4	4.5	12.1

* 1 - Length M_1. 2 - Width M_1. 3 - Alveolar length $P_3 - M_2$.
4 - Mandible depth below centre of M_1. 5 - Ascending ramus depth.

Table 37. Measurements of a Pleistocene mandible fragment from the Yukon Territory tentatively referred to ermine *(Mustela erminea)* compared to mandibles of Recent ermine, long-tailed weasels *(Mustela frenata)* and least weasels *(Mustela nivalis)* from Canada.

Specimens	Sex	Measurements (mm)* 1	2	3
Mustela erminea. Pleistocene, Y.T.				
NMC 25076	–	5.8	4.2	2.5
Mustela erminea. Recent, Y.T.				
NMC 35870	♀	6.0	4.0	2.6
NMC 2109	♀	4.0	3.1	1.7
NMC 18095	♂	4.5	3.1	2.1
NMC 2120	♂	4.6	3.4	2.0
NMC 18021	♂	5.0	4.0	2.5
NMC 31075	♀	4.7	3.2	2.0
Mustela frenata. Recent				
NMC 29234 B.C.	♂	6.3	5.0	2.9
NMC 76530 Alta.	♀	5.7	4.2	2.7
NMC 8060 Alta.	♂	7.1	5.4	3.1
NMC 10884 Alta.	♀	5.8	5.3	2.8
NMC 27117 Alta.	♂	6.4	5.3	3.4
NMC 10872 Alta.	♀	6.4	4.7	3.0
Mustela nivalis. Recent				
NMC 34110 Y.T.	♂	3.6	2.5	1.5
NMC 34370 N.W.T.	♂	3.8	2.3	1.6
NMC 34371 N.W.T.	♂	3.4	2.2	1.6
NMC 30622 –	♂	3.6	2.9	1.9
NMC 39761 Y.T.	♂	4.3	3.1	1.9
NMC 21097 N.W.T.	♀	3.1	2.2	1.5

* 1 – Length M_1. 2 – Mandible depth below centre of M_1.
3 – Mandible width at centre of M_1.

27545) are larger in most respects than the Canadian Pleistocene and Recent ermine specimens measured.

A right mandibular fragment (NMC 25076) containing the basal region of RM_1 and parts of its posterior cusps, and lacking the ascending ramus and the portion of the jaw anterior to RM_1, is tentatively referred to *Mustela erminea*. It was collected at Old Crow Locality 27W and is stained black. The only feature in which it varies from Recent and Pleistocene North American ermine specimens to which it was compared is in the somewhat greater length of RM_1 (but it is exceeded in this measurement by a Recent female from the Yukon (NMC 35870)). There is a possibility that NMC 25076 could represent the long-tailed weasel *(Mustela frenata)* (Table 37), but this is considered unlikely. Although the least weasel *(Mustela nivalis)* may be expected to occur in Yukon Pleistocene deposits (Youngman 1975, p. 147), this fossil is too large to belong to that species.

A complete right ulna (NMC 25320) of the ermine was screened from organic sandy gravel overlying the basal clay unit at Old Crow Locality 27W. It is stained orange and could be younger in geological age (late Wisconsin?) than the specimen previously mentioned. The

ulna is 26.7 mm long and matches closely a Recent ermine specimen from Canada, NMC 29833.

Discussion

Ermine fossils have not been reported previously from Pleistocene deposits in Canada or Alaska. Presently, the species has a Holarctic distribution. The subspecies that now live in the Yukon - *Mustela erminea arctica* in the north and *Mustela erminea richardsoni* in the south - may indicate a Beringian origin for the former and a southern origin for the latter (Macpherson 1965, p. 164; Youngman 1975, p. 142).

The origins of *Mustela erminea* are poorly known. Possibly it arose during the latter part of the middle Pleistocene. It is commonly represented in European deposits of last interglacial (Sangamon) and last glacial (Wisconsin) age. Ermine have been present in North America since Illinoian time (Kurtén 1968, p. 102).

Ermine are agile hunters that feed mainly on rodents, shrews and hares. They occupy a wide range of habitats from boreal and mixed forests to arctic and alpine tundra.

Mustela (Putorius) eversmanni
(black-footed ferret)

Two mandibles (Figure 37A-C, Table 38) of large ferrets have been collected from Pleistocene deposits in the Old Crow Basin. They constitute the first records of this species in the Yukon Territory.

Referred specimens

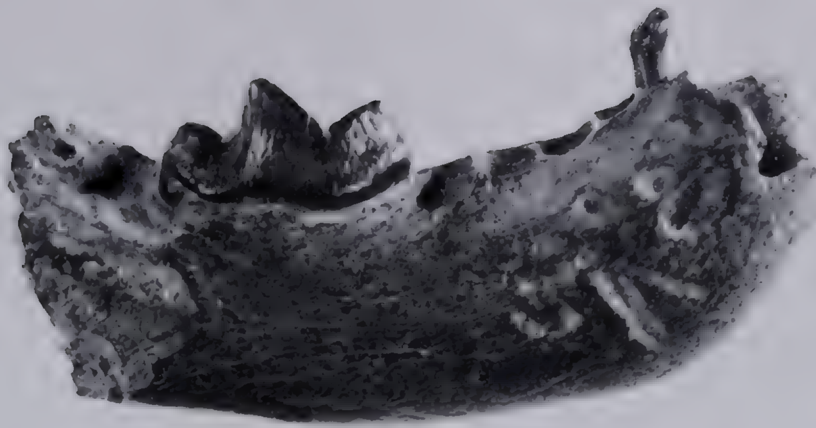
NMC 16323 from Old Crow Locality 65 is a right mandible with RP_2 and RM_1 and complete or partial alveoli for the canine, RP_3, RP_4 and RM_2. The narrow talonid and absence of a metaconid on M_1 serve to distinguish this fossil and black-footed ferret mandibles from those of the true weasels of the subgenus *Mustela*. The ascending ramus of NMC 16323 is lacking and the anterior tip of the mandible is damaged. The anterior part of the masseteric fossa extends forward to a point below the posterior root of M_1. I am grateful to Elaine Anderson for identifying this specimen. It is similar in size to a Recent black-footed ferret jaw from Texas (UMMZ 76971). The degree of wear on RM_1 and the fact that the root of RP_2 is exposed well above the alveolar margin are presumably indicative that an old individual is represented. The specimen is stained dark brown.

Figure 37. Right mandible with RP_2 and RM_1 (NMC 16323, Old Crow Locality 65) of a Pleistocene black-footed ferret *(Mustela (Putorius) eversmanni)*.

A. Lateral view.

B. Occlusal view.

C. Medial view.



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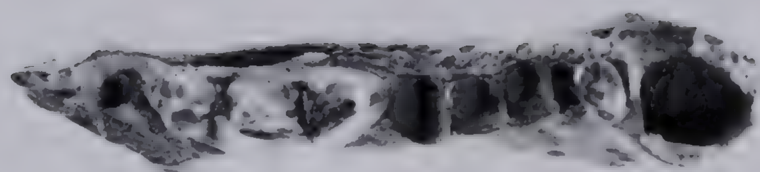
A



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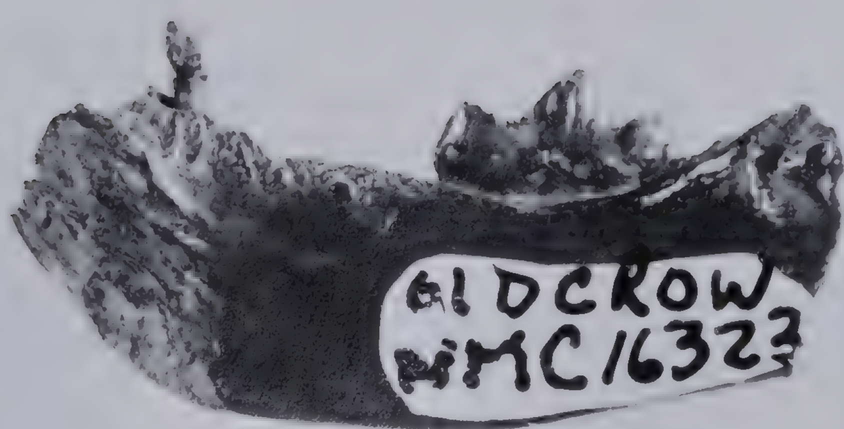

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C

Table 38. Measurements of Pleistocene black-footed ferret (*Mustela (Putorius) eversmanni*) mandibles from the Yukon Territory compared to those of some Pleistocene and Recent black-footed ferrets from the United States.

Specimens	Sex	Measurements (mm)*								
		1	2	3	4	5	6	7	8	9
Mustela (Putorius) eversmanni. Pleistocene, Y.T.										
NMC 16323 Old Crow Loc. 65	-	7.4	4.5	2.5	1.6	-	-	8.3	3.3	20.2
NMC 25079 Old Crow Loc. 83	-	9.1	5.2	-	-	2.9	2.3	9.2	3.2	20.2
Mustela (Putorius) eversmanni. Recent, U.S.										
UMMZ 76971 Texas	♂	9.1	4.6	2.5	1.7	3.2	2.2	8.6	3.2	18.9
Mustela (Putorius) eversmanni. Pleistocene, Little Box Elder Cave, Wyoming (Anderson 1968, p. 34)										
M		-	-	-	-	-	-	8.0	2.7	-
OR		-	-	-	-	-	-	7.3-8.9	2.1-3.0	-
N		-	-	-	-	-	-	24	22	-
Recent, Colorado (Anderson 1968, p. 34)										
M		-	-	-	-	-	-	7.3	2.7	-
OR		-	-	-	-	-	-	7.0-7.6	2.4-2.9	-
N		-	-	-	-	-	-	4	4	-
Recent, Texas (Anderson 1968, p. 34)										
M		-	-	-	-	-	-	-	2.8	-
OR		-	-	-	-	-	-	7.7	2.7-2.9	-
N		-	-	-	-	-	-	2	2	-

* 1 - Mandible depth below centre of M_1. 2 - Mandible width below centre of M_1. 3 - P_2 length. 4 - P_2 width. 5 - P_3 length. 6 - P_3 width. 7 - M_1 length. 8 - M_1 width. 9 - Alveolar length P_2-M_2.

NMC 25079 from Old Crow Locality 83 is a right mandible with RP_3 and a damaged RM_1. Part of the canine socket is lacking, while alveoli for RP_2, RP_4 and RM_2 are present. The mandibular foramen is preserved in this fossil but not in NMC 16323. The specimen is comparable to a Recent black-footed ferret mandible (UMMZ 76971). It is interesting to note that NMC 25079 was excavated from oxidized, organic, fine gravel overlying the basal clay unit, as was NMC 16323, which was collected one bend downstream from Old Crow Locality 83.

Discussion

The dark staining of both fossils suggests a pre- late Wisconsin age. The only other Canadian Pleistocene record is a mandible from Sangamon interglacial deposits at Medicine Hat, Alberta (Anderson 1973, p. 778).

The anterior part of a skull and two left mandibles from Pleistocene sediments near Fairbanks, Alaska most closely resemble the largest steppe ferret subspecies *Mustela (Putorius) eversmanni michnoi*, which occurs in the Transbaikal region of Siberia. *M. eversmanni* is similar in size, cranial and dental morphology, and external appearance to North American *M. nigripes*; I follow Anderson's (1973, p. 778) suggestion in considering them to be conspecific. The species name *eversmanni* has

precedence over *nigripes*.

In the conterminous United States, there are records of Wisconsin age from Burnet Cave and Isleta Caves in New Mexico, and Little Box Elder Cave in Wyoming (Anderson 1968, pp. 31-33).

Ferrets are not recorded in the most important Pleistocene vertebrate faunas of northeastern Siberia.

The earliest known true ferret *(Mustela (Putorius) stromeri)* appeared in the late Villafranchian of Europe, where it survived until late Günz (late ?Nebraskan) time. It may have given rise to the living Eurasian polecat *Mustela (Putorius) putorius*, from which the larger *M. (P.) eversmanni* may have stemmed. Either or both of these mustelids are known from the Cromer (?Aftonian) interglacial and Mindel (?Kansan) glacial deposits of England and Germany. *M. eversmanni* is definitely known from the Eem (Sangamon) and Würm (Wisconsin) of Europe (Kurtén, pp. 98-100).

Although some key pieces of evidence are missing, I postulate that black-footed ferrets were derived from ferrets like *M. (P.) putorius* in the middle Pleistocene,

and that they first entered North America via the Bering Isthmus during the Illinoian glaciation (when steppe conditions would have been conducive to their dispersal (Hopkins 1967, pp. 472-473)), reaching central North America (Medicine Hat) by the Sangamon interglacial. The discovery of black-footed ferret remains in the Old Crow Basin and central Alaska strongly indicates the presence of dry grasslands with abundant rodents in those places during the late Pleistocene.

The black-footed ferret is a large, whitish mink-sized mustelid with a dark brown "mask". The legs, feet and end of the tail are of similar chocolate color. Its Holarctic distribution is presently broken in the Beringian area where the species became regionally extinct, or which it abandoned, during the late Pleistocene. The Palearctic group ranges from southeastern Europe to western China: the Nearctic group occurs in west central North America. It is interesting to note that the Eurasian group is increasing in numbers and moving northward, while the North American group is undergoing a marked reduction in numbers, and its historic range, which extended from Texas to the southern prairies of Canada, is contracting. Indeed, the species is near the point of extinction in North America (Banfield 1974, p. 329).

The preferred habitat of the species is arid short-grass prairies or steppe, and it is a good paleoenvironmental indicator of that kind of habitat. Black-footed ferrets often usurp rodent burrows for their dens, usually enlarging them. They are keen hunters, preying mainly on rodents such as prairie dogs *(Cynomys ludovicianus)*, ground squirrels (*Spermophilus* sp.), hares, voles and marmots (Stroganov 1969, p. 384; Banfield 1974, p. 328). In Siberia, their main prey is the red-cheeked ground squirrel *(Spermophilus majori)*, and I suggest that, as prairie dogs have not been reported from the Yukon or Alaska, they probably focussed their hunting on arctic ground squirrels *(Spermophilus undulatus)* and possibly pikas (*Ochotona* sp.), which were common in parts of Eastern Beringia during the late Pleistocene. At Medicine Hat, however, both prairie dogs and ground squirrels were available as prey for black-footed ferrets during the Sangamon interglacial (Stalker and Churcher 1970; C.S. Churcher, personal communication 1973).

During the first half of the 1900s, European settlers in western North America waged a constant war against prairie dogs by poisoning, trapping and shooting them in order to protect the crops they cultivated. Thus, prairie dog range, and consequently black-footed ferret

range, became greatly restricted.

Martes nobilis (noble marten)

This species (Figures 38A-C, 39A-D, Tables 39-40) has not been reported previously from Eastern Beringia or Canada. Three specimens from Pleistocene deposits in the Old Crow Basin, two mandibles and a humerus, have the general characteristics and proportions of the noble marten as outlined by Anderson (1970, pp. 73-86).

Referred specimens

NMC 24360 from Old Crow Locality 11A is a right mandible with RP_3-RM_1. The root of the canine is lodged in its damaged socket, and alveoli are present for RP_2 and RM_2. No trace of RP_1 or its alveolus is evident. The teeth are heavily worn indicating that an old individual is represented. Two mental foramina are seen. The anterior one lies below the anterior root of P_2, while the posterior one is situated below the centre of P_3. They are similarly located in another fossil mandible from the Yukon (NMC 19098). The ascending ramus is intact. Its posterior profile is convex, the posteriormost projection being midway between the lower border and the tip of the coronoid process. This feature appears in a noble marten mandible (UCMP 9389) from Samwel Cave, California

Figure 38. Right mandible with RP_3-RM_1 (NMC 24360, Old Crow Locality 11A) of a Pleistocene noble marten *(Martes nobilis)*.

A. Lateral view.

B. Occlusal view.

C. Medial view.

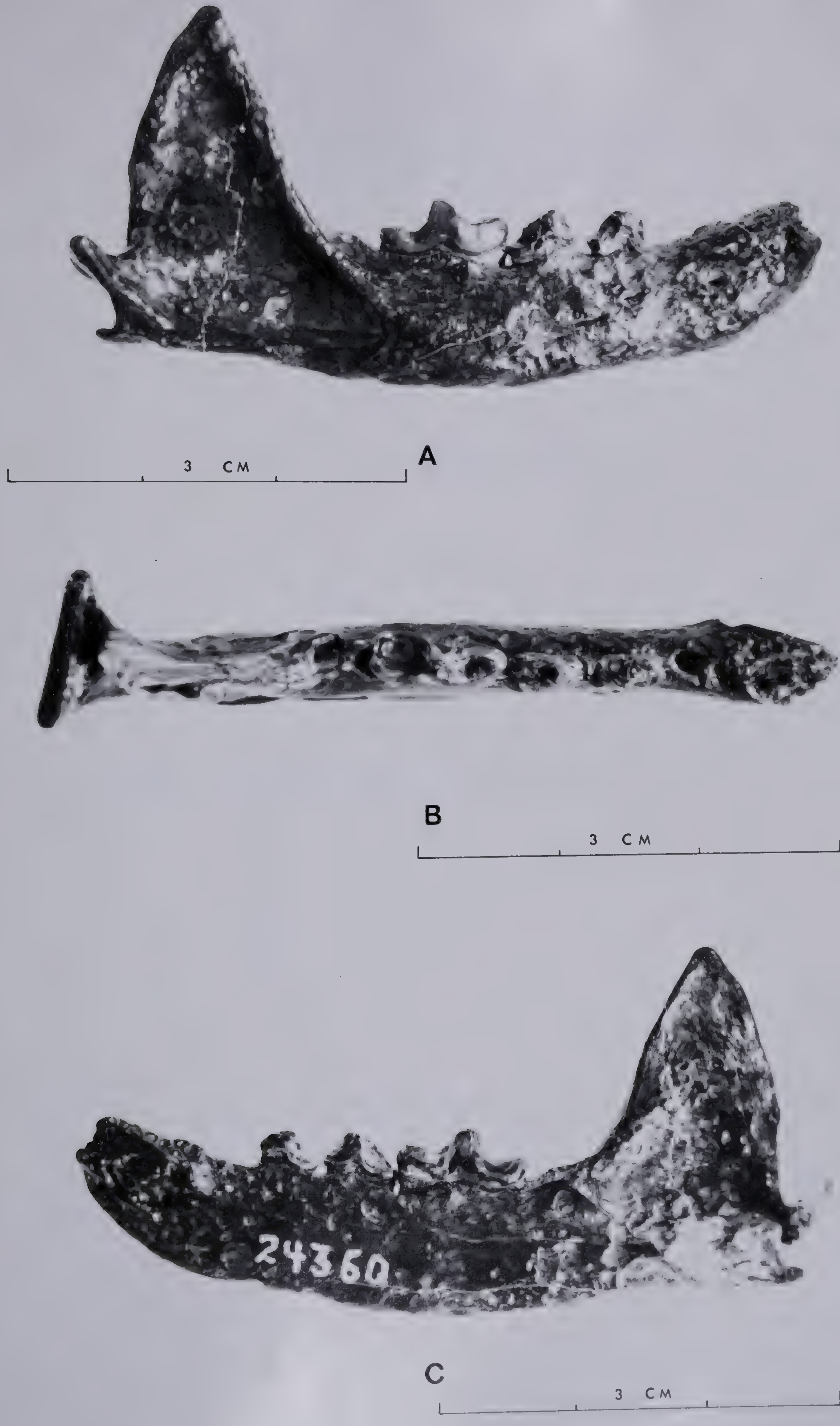

A
3 CM
B
3 CM
24360
C
3 CM

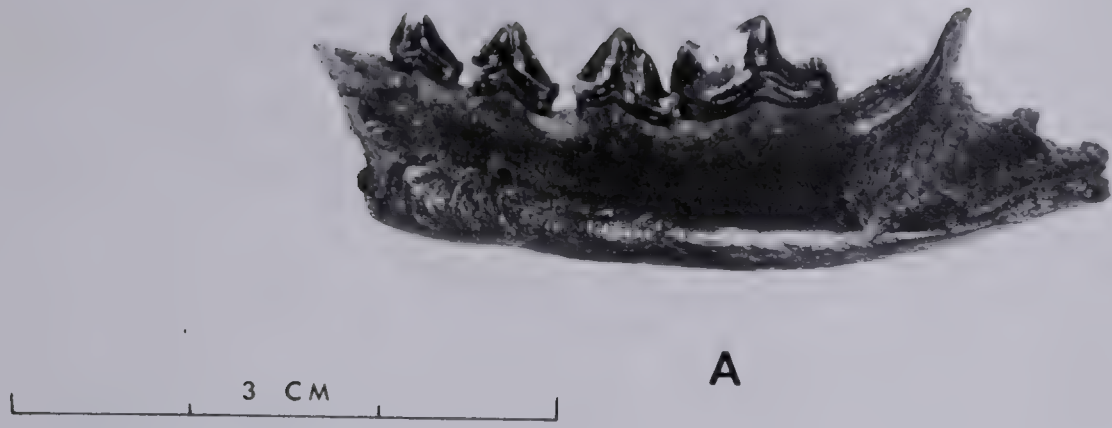
Figure 39. Left mandible with LP_2-LM_1 (NMC 19098, Old Crow Locality 28) of a Pleistocene noble marten *(Martes nobilis)*.

A. Lateral view.

B. Occlusal view.

Left humerus (NMC 28605, Old Crow Locality 65) of a Pleistocene noble marten *(Martes nobilis)*.

C. Anterior view. D. Posterior view.



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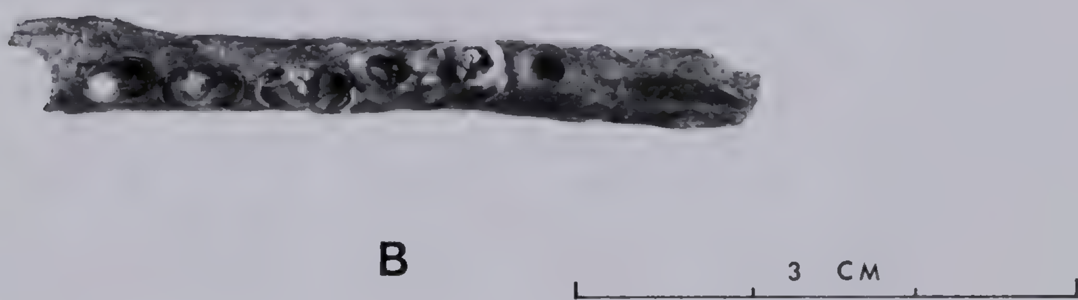

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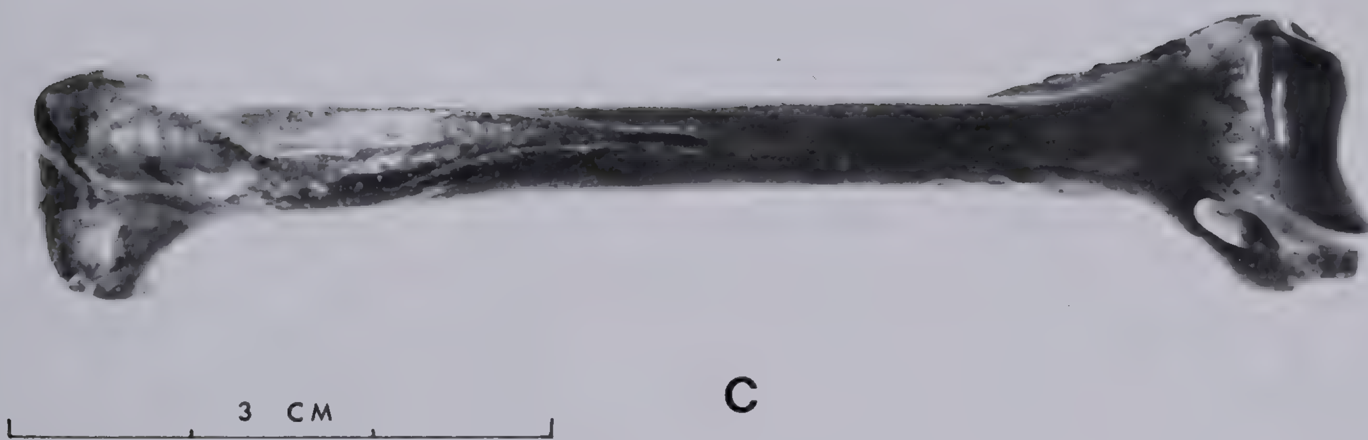

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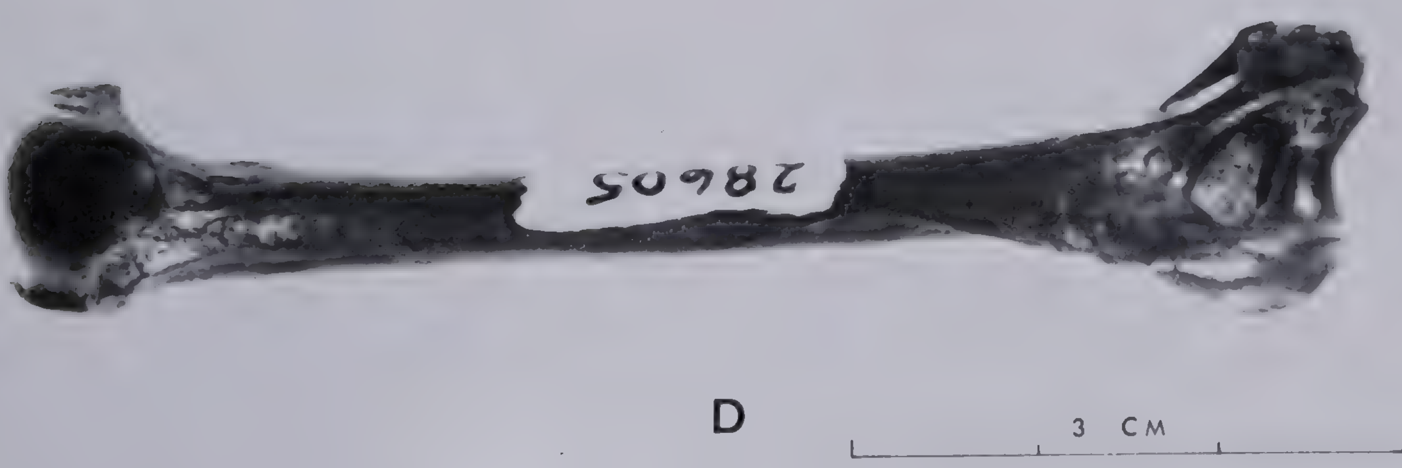


D

Table 39. Measurements of Pleistocene noble marten (*Martes nobilis*) mandibles from the Yukon Territory compared to those of Pleistocene noble martens from the western United States.

Specimens	Measurements (mm)*											
	1	2	3	4	5	6	7	8	9	10	11	12
Martes nobilis. Pleistocene, Y.T.												
NMC 24360 Old Crow Loc. 11A	10.1	5.2	-	-	4.8	2.4	5.9	2.9	9.9	3.7	6.6	30.9
NMC 19098 Old Crow Loc. 28	9.5	4.7	4.4	2.6	5.5	2.7	6.1	3.1	9.8	3.8	6.6	30.3
Martes nobilis. Pleistocene, U.S.A. (Anderson 1970, p 78, Table 26)												
Males												
M	-	-	4.8	2.6	5.1	2.8	6.0	3.3	11.1	4.2	7.4	-
N	-	-	2	2	4	4	6	6	9	8	9	-
OR	-	-	-	2.5-2.6	5.0-5.3	2.6-3.0	5.5-6.5	3.1-3.7	10.8-11.3	3.7-4.6	7.1-7.8	-
SD	-	-	-	-	0.14	0.20	0.34	0.22	0.19	0.21	0.23	-
Females												
M	-	-	4.3	2.4	4.9	2.6	5.5	3.1	10.1	4.1	6.9	-
N	-	-	10	11	12	12	8	8	15	14	15	-
OR	-	-	3.9-4.6	2.2-2.6	4.6-5.2	2.4-2.8	5.2-5.9	2.8-3.2	9.6-10.5	3.8-4.5	6.5-7.2	-
SD	-	-	0.22	0.12	0.19	0.11	0.24	0.14	0.26	0.20	0.20	-

* 1 - Mandible depth below centre of M_1.

2 - Mandible width below centre of M_1.

3 - P_2 length.

4 - P_2 width.

5 - P_3 length.

6 - P_3 width.

7 - P_4 length.

8 - P_4 width.

9 - M_1 length.

10 - M_1 talonid length.

11 - M_1 trigonid length.

12 - Alveolar length, posterior of canine alveolus to posterior of alveolus for M_2.

Table 40. Measurements of a Pleistocene noble marten *(Martes nobilis)* humerus from the Yukon Territory compared to those of noble martens from the western United States.

Specimens	Measurements (mm)*						
	1	2	3	4	5	6	7
Martes nobilis.Pleistocene, Y.T.							
NMC 28605 Old Crow Loc. 65	74.6	12.9	12.2	5.1	6.2	16.0	8.4
Martes nobilis.Pleistocene, U.S.A. (Anderson 1970, p. 82, Table 28)							
Males							
M	74.3	13.5	-	5.5	-	17.0	-
OR	72.4-77.8	12.8-14.5	-	4.9-6.0	-	15.8-18.3	-
N	3	3	-	4	-	4	-
Females							
M	61.0	10.5	-	4.2	-	13.0	-
OR	57.2-66.3	9.8-11.9	-	3.7-4.5	-	12.2-14.5	-
N	8	9	-	9	-	6	-

* 1 - Total length
2 - Proximal width
3 - Proximal depth
4 - Midshaft width
5 - Midshaft depth
6 - Distal width
7 - Distal depth

(Anderson 1970, p. 76, Figure 26). The height of the ascending ramus of NMC 24360 is 25.4 mm and the width of the condyloid process is 11.4 mm. The surface of this blackish brown fossil is minutely pitted, which I attribute to the activity of acids in the groundwater. The specimen is intermediate in size between mandibles of the American marten *(Martes americana)* and the fisher *(Martes pennanti)*, and the trigonid of M_1 is relatively shorter than in *M. americana* or *M. pennanti*. When plotted on Anderson's (1970, p. 82, Figure 31) scattergram showing relationship between M_1 length and M_1 trigonid length in *M. nobilis* (Pleistocene), *M. diluviana* (Pleistocene), *M. pennanti* (Recent) and *M. americana* (Pleistocene, postglacial and Recent), NMC 24360 clearly falls in the lower range of *Martes nobilis*, as does the other Yukon specimen NMC 19098, which falls just beside NMC 24360. I am grateful to Elaine Anderson (personal communication 1975) for examining a cast of NMC 24360 and confirming my identification of it as *Martes nobilis*.

NMC 19098 from Old Crow Locality 28 is a left mandible with LP_2-LM_1 and the alveolus for LM_2. The anterior part of the mandible is damaged leaving only the posterior half of the canine socket. The teeth are slightly worn indicating that an individual in early

maturity is probably represented. Most of the ascending ramus is lacking. What appear to be two tooth marks are located side by side 3.9 mm apart on the inner surface of the mandible below the socket for LM_2. Perhaps they were made by another marten and are indicative of intra-specific strife, or maybe they were made by another predator, such as the fisher. The surface of this specimen is much better preserved than that of NMC 24360, so there is no danger of mistaking these marks for pits eroded by acidic groundwater. As has been noted previously, NMC 19098 possesses the features, such as the diagnostic measurements and proportions of LM_1, that enable it to be identified as *Martes nobilis*. It is dark brown in color; slightly paler than NMC 24360. Comparative measurements of the mandibles from the Old Crow Basin suggest both represent females.

NMC 28605 from Old Crow Locality 65 is a complete left humerus of a marten that is larger than male American martens and smaller than the fisher. In morphological features it matches a humerus of *M. nobilis* from Little Box Elder Cave, Wyoming (Anderson 1970, p. 80, Figure 28), and in size it lies within the observed ranges and near to the means for specimens attributed to males of the noble marten by Anderson (1970, p. 82).

It is therefore referred to *Martes nobilis*.

Discussion

The Yukon specimens are probably of pre- late Wisconsin age. Although NMC 19098 was excavated from organic sand overlying the basal clay unit at Old Crow Locality 28, it is not a high bluff exposure like Old Crow Locality 44, and the upper sands containing the fossils may well have been reworked and deposited during post-glacial time. Fossils of this species may be expected to occur in Pleistocene sediments of Alaska and southwestern Canada.

Apart from the Yukon records, *M. nobilis* is known only from late Wisconsin age deposits in Samwel and Potter Creek caves, California; Little Box Elder Cave, Wyoming; and Jaguar Cave, Idaho (Anderson 1970, p. 73). It was Nearctic in distribution.

The dispersal history of *M. nobilis* is not very clear. In the late Astian (late Pliocene) and perhaps the early Villafranchian a large marten, *M. wenzensis*, lived in Europe (Kurtén 1968, p. 93). It could have given rise to the next martens *(M. vetus)* that appeared in Europe during the early Pleistocene (Anderson 1970, p. 121). The Eurasian pine marten *(M. martes)* probably arose from

M. vetus in the middle Pleistocene. According to Anderson (1970, p. 124), the noble marten may have stemmed from the basic pine marten stock, but the details of their relationship are not spelled out.

It is interesting to note the similarities, yet radical difference between *M. nobilis* and *M. diluviana* of middle Pleistocene (?Kansan to Illinoian from Port Kennedy Cave, Pennsylvania; Cumberland Cave, Maryland; and Conard Fissure, Arkansas) age from the eastern United States. Statistical analyses show that *M. nobilis* was more like *M. diluviana* than *M. americana* in structural proportions. Scattergrams of M_1 length and M_1 trigonid length show that *M. nobilis* lies on a different trend axis than *M. americana* or *M. pennanti*, but one that is very close to *M. diluviana*. Limb bones of the noble marten were similar in proportions to *M. diluviana*, but different from *M. americana* and *M. pennanti*. Anderson (1970, p. 77) thought at first that *M. nobilis* was a subspecies of *M. diluviana* that had survived until the late Pleistocene, but subsequently showed that the former was a true marten rather than a fisher, for it lacks an external median rootlet on P^4. Evidently the genus *Martes*, in fisher (*M. diluviana*) and marten (*M. nobilis*) forms, had two chances to exploit a similar North American environmental

niche in a similar way and failed both times.

Certainly, *M. nobilis* is not closely related to *M. americana*. Probably the former species or its ancestors entered North America from Asia in late Illinoian or early Wisconsin times and spread into forested western regions where it survived in relict populations until its extinction in the early postglacial (Anderson 1970, pp. 85-86). In the southern part of its range, perhaps warming climate and human activity, besides competition with the American marten, caused its extinction.

Some characteristics of living American martens are provided, as they are probably grossly comparable to those of noble martens. Males are about 15% larger than females. Young are born in leaf-lined nests, in hollow trees, or in cavities in rock piles or under stumps or brush. They prefer coniferous forest, avoiding burned-over areas. A resumé of paleoenvironmental evidence from the cave deposits in which fossils of the noble marten have been found suggests that cool coniferous forest with nearby tundra-like conditions may have been its favored habitat. Certainly this type of landscape could have been found in the Yukon Territory during the late Pleistocene (McAllister and Harington 1969, pp. 1188-1189;

Harington and Clulow 1973, p. 743). American martens commonly prey on voles, particularly red-backed voles *(Clethrionomys rutilus)*, a species that is known to have occurred in the Old Crow Basin during the late Pleistocene. Red squirrels, hares and pikas are also eaten, as are berries in summer. At present human trappers are their main predators. Occasionally fishers, lynx, coyotes, owls and eagles prey on them (Banfield 1974, pp. 315-318).

Martes pennanti (fisher)

Two specimens (Figure 40A-C, Table 41) from Pleistocene deposits in the Old Crow Basin are referred to the fisher, a species that has not been reported previously from Eastern Beringia or Canada.

Referred specimens

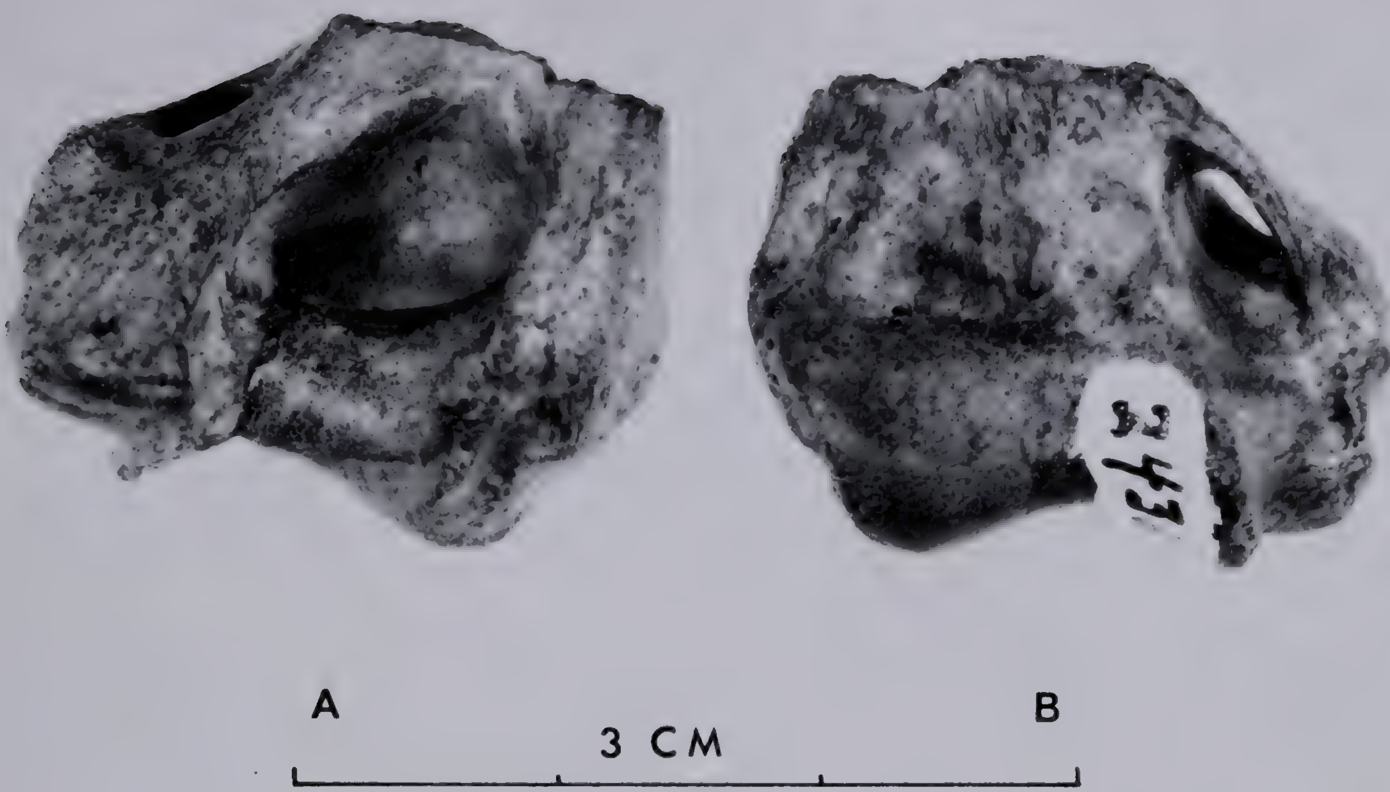
NMC 24368 from Old Crow Locality 11A is the distal end of a right humerus. The slip of bone enclosing medially the entepicondylar foramen is intact, and all features of the distal articular surface including the olecranon fossa are well preserved. The specimen is much larger in distal width than the largest referred males of *Martes nobilis* recorded by Anderson (1970, p. 80, Table 28). Of three Recent fisher humeri to which the

Figure 40. Distal end of a right humerus (NMC 24368, Old Crow Locality 11A) of a Pleistocene fisher *(Martes pennanti)*.

A. Posterior view.

B. Anterior view.

C. Anterior view of a right calcaneum (NMC 22322, Old Crow Locality 27W) of a Pleistocene fisher *(Martes pennanti)*.



C

Table 41. Measurements of a Pleistocene fisher *(Martes pennanti)* humerus from the Yukon Territory compared to those of Recent fishers from Quebec.

Specimens	Sex	Measurements (mm)* 1	2	3
Martes pennanti. Pleistocene, Y.T.				
NMC 24368 Old Crow Loc. 11A	-	25.5	8.3	15.9
Martes pennanti. Recent, Quebec				
NMC 16142	-	24.6	7.3	16.1
NMC 34632	♂	24.2	7.4	16.1
NMC 16143	♀	19.7	5.9	13.0

* 1 - Distal width.

2 - Minimum anteroposterior diameter of distal articulation.

3 - Width across anterior articular surface.

fossil was compared, it most closely resembles that of an adult male from Quebec (NMC 34632). The specimen is stained brown and appears to be of pre- late Wisconsin age.

NMC 22322 from Old Crow Locality 27W is a complete right calcaneum. It is similar to, but slightly larger than, the same element of a Recent Quebec fisher (NMC 34632). It is interesting to note the great degree of similarity between the fossil calcaneum and that of the Recent Asian yellow-throated marten, *Martes flavigula* (Gromova 1960, p. 56, Figure 14A). The maximum measurements of the fossil are: 30.3 mm long x 16.0 mm wide x 13.4 mm deep. The fossil calcaneum is similar in all basic morphological features to the same bone of a Recent male fisher from Quebec (NMC 34632), and is slightly larger than the latter specimen, which has maximum measurements of: 27.7 mm long x 16.0 mm wide x 12.7 mm deep. It is stained blackish brown and has many rootlet impressions on its surface.

Discussion

Although Youngman (1975, p. 142) states that the present distribution and ecology of the fisher suggest that it is a postglacial immigrant to the Yukon Territory, the fossils from the Old Crow Basin indicate its presence there earlier, in pre- late Wisconsin time. Perhaps during the

Sangamon interglacial suitable boreal forest habitat reached the Old Crow Area, and the fossils may be of that age. More evidence is required to solve this and other zoogeographic problems relating to the fisher.

Isolated teeth and jaw fragments with teeth have been reported from a number of late Wisconsin sites in the eastern United States, such as New Paris No. 4, Pennsylvania; Natural Chimneys, Virginia; Robinson Cave, Tennessee; and Ladds, Georgia. These localities are south of the present range of the fisher and probably were occupied by fishers during the peak of the Wisconsin when the boreal forest had shifted south before the advancing margin of the ice sheet. Anderson (1970, p. 91) refers fossil mandibles from Conard Fissure, Arkansas, which were previously reported as *M. pennanti* by Brown, to *M. diluviana*.

The origins of *Martes pennanti* are uncertain, but *M. paleosinensis*, which was about the size of a female fisher and which has been found in early Pliocene deposits of Shansi, China, was its direct or indirect (via *M. diluviana*) ancestor. *M. paleosinensis* has the external median rootlet on P^4 characteristic of the fishers (subgenus *Pekania*). *M. diluviana*, which apparently

entered North America via the Bering Isthmus during the Kansan glaciation, could have been the direct ancestor of *M. pennanti*, but there is a critical gap in the fossil evidence. Anderson (1970, p. 126) seems to favor a second dispersal from eastern Asia to North America of a stock related to *M. paleosinensis* in late Illinoian or early Wisconsin times to explain the presence of *M. pennanti* there.

Martes pennanti is the largest living member of the genus *Martes*. It resembles a large black cat, but its body is more slender, its eyes are smaller and its limbs are shorter. No subspecies are recognized (Hagmeier 1959). The fisher is confined to North America. It is more southern in distribution than the American marten, occupying the broad belt of boreal forest that crosses north-central North America. It also occurs in the eastern hardwood forest and parts of the Cordillera, and occupies the extreme southeastern corner of the Yukon Territory. Fisher remains are probably paleoenvironmental indicators of boreal forest conditions. Unlike American marten, fishers will venture into deciduous groves and old burned-over areas. Fishers tend to be solitary. They make dens in hollow trees, and in crevices in rocks and brush piles. Populations

fluctuate with a period of about 10 years. Red-backed voles, snowshoe hares, red squirrels and shrews are favorite prey. The first two species are known to have lived in the Old Crow Basin of the Yukon during late Pleistocene time. Fishers also commonly eat birds and fruit. At present, people are the only important predator of the fisher.

Gulo gulo (wolverine)

Many wolverine (Figures 41A-C, 42A-D, Tables 42-43) fossils have been collected in the Old Crow Area. Only a few of the better specimens containing teeth will be described.

Referred specimens

The most complete specimen consists of a fragmentary cranium (NMC 14582) of what appears to be an adult male on the bases of nearly complete suture fusion, large zygomatic breadth and great occipital height (which includes the sagittal crest, usually prominent in adult male wolverines). The specimen was excavated from a sand bar opposite Old Crow Locality 22, whence it had evidently been washed from farther upstream. A unique feature of the fossil, which suggests that it may not be so old as most other darkly stained bones from the lower

Figure 41. Cranium (NMC 14582, bar opposite Old Crow Locality 22) of a Pleistocene to Recent wolverine *(Gulo gulo)*.

A. Dorsal view. B. Right lateral view. C. Ventral view. Note white teeth relative to the heavily weathered and stained cranial bone.

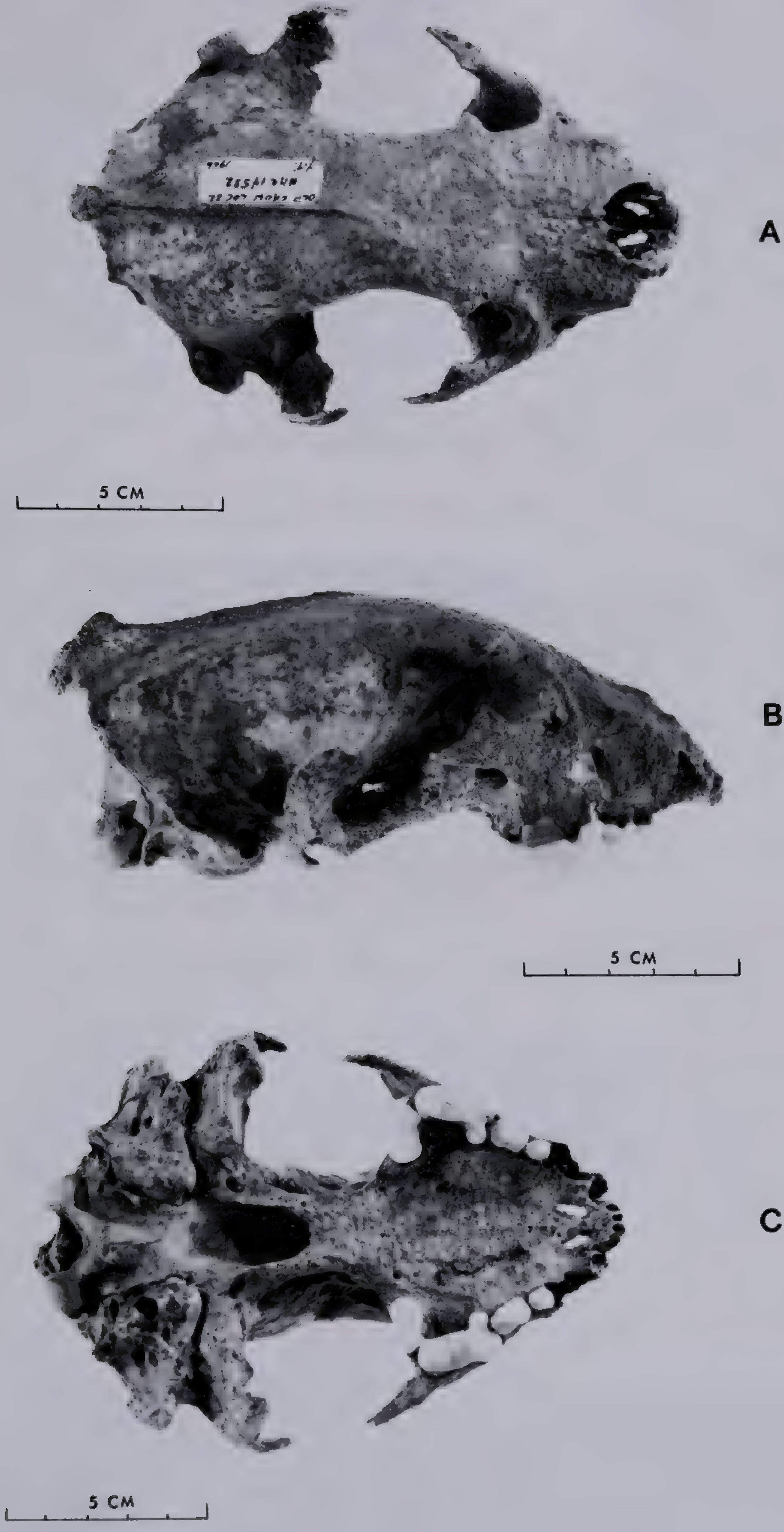

A
5 CM
B
5 CM
C
5 CM

Figure 42. Left mandible with LP_2-LM_1 (NMC 20746, Old Crow Locality 20) of a Pleistocene wolverine *(Gulo gulo)*.

A. Lateral view. B. Occlusal view.

Right mandible with RP_2-RM_1 (NMC 24797, Old Crow Locality 22E) of a Pleistocene wolverine *(Gulo gulo)*.

C. Lateral view. D. Occlusal view.


A
B
3 CM
3 CM
C
D

Table 42. Measurements of Pleistocene wolverine *(Gulo gulo)* crania from the Yukon Territory compared to those of Recent wolverines from the Yukon Territory.

Specimens	Sex	Measurements (mm)*																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Gulo gulo.Pleistocene, Y.T.																			
NMC 14582 Old Crow Loc. 22	-	44.7	39.5	37.1	102.3	55.6	35.7	90.5	127.5	34.9	6.3	5.6	10.5	6.5	20.8	12.0	8.1	14.2	68.0
NMC 16321 Old Crow Loc. 65	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19.4	10.4	-	-	-
Gulo gulo luscus.Recent, Y.T.																			
NMC 33692	♂	44.1	39.1	34.4	107.3	57.2	37.9	90.0	130.5	37.2	7.2	4.9	10.5	6.5	22.4	11.9	8.8	14.8	67.8
NMC 31776	♂	42.5	41.8	34.5	103.8	51.2	37.1	88.6	131.0	38.2	7.0	5.0	10.9	6.6	21.5	12.4	8.2	14.0	66.3
NMC 34310	♂	42.6	40.7	35.7	100.3	50.2	36.2	87.1	131.6	35.8	7.0	4.7	9.7	6.8	20.4	11.8	7.8	13.9	63.6
NMC 31773	♂	40.4	41.2	32.2	99.1	52.4	39.4	84.0	127.9	33.9	5.8	4.1	10.0	5.8	20.3	11.5	8.0	13.5	61.6
NMC 34311	♂	42.9	39.6	34.1	98.6	48.0	35.5	88.4	126.9	33.9	6.9	4.7	10.3	7.3	20.7	11.5	7.9	13.5	64.0
NMC 31054	♂	42.4	39.3	32.9	98.3	48.4	36.3	90.6	133.5	35.8	6.5	4.6	9.7	6.3	20.6	11.5	7.7	14.3	62.0
NMC 31055	♀	40.7	38.1	33.4	95.6	47.2	32.8	84.1	120.9	33.3	6.3	4.2	8.8	5.5	18.2	10.5	6.9	12.5	59.2e
NMC 34309	♂	39.7	36.8	33.1	95.5	50.8	33.3	81.3	119.8	32.9	6.4	4.6	10.3	5.7	19.1	10.9	7.2	12.2	59.2
NMC 31709	♀	41.3	38.9	34.3	94.1	45.9	35.4	80.9	118.1	32.1	6.0	4.3	8.7	5.6	19.2	10.2	7.5	12.9	58.4
NMC 31775	♀	38.6	35.4	30.4	92.6	45.0	33.3	82.1	122.8	32.1	6.4	4.4	9.5	5.7	18.7	11.4	7.3	12.7	58.8
NMC 31056	♀	39.7	36.9	33.0	89.9	46.6	33.9	82.5	119.8	31.9	6.3	6.0	9.8	5.6	18.8	10.2	10.9	6.4	57.4

* 1 - Minimum rostral width at infraorbital foramen.

2 - Interorbital width.

3 - Width at postorbital constriction.

4 - Zygomatic width.

5 - Occipital height (ventral lip of foramen magnum to top of sagittal crest).

6 - Width of occipital condyles.

7 - Maximum width across mastoid processes.

8 - Basilar length.

9 - Alveolar length P^3- M^1.

10 - Length P^3.

11 - Width P^3.

12 - Length P^4.

13 - Width P^4.

14 - Length M^1.

15 - Width (anterior) M^1.

16 - Length M^2.

17 - Width M^2.

18 - Maximum width across outer surface of M^1s.

Table 43. Measurements of Pleistocene wolverine *(Gulo gulo)* mandibles from the Yukon Territory compared to those of Recent wolverines from the Yukon Territory.

Specimens	Sex	Measurements (mm)*												
		1	2	3	4	5	6	7	8	9	10	11	12	13
Gulo gulo. Pleistocene, Y.T.														
NMC 24797 Old Crow Loc. 22E	–	30.6	20.1	9.0	19.3	10.0	6.2	4.3	7.9	5.4	11.4	6.3	20.3	8.9
NMC 20746 Old Crow Loc. 20	–	31.3	22.2	11.6	21.1	11.2	6.9	4.4	8.9	5.4	11.2	6.6	21.0	9.1
NMC 24236 Old Crow Loc. 22	–	29.4	18.7	9.9	16.9	9.6	–	–	–	–	10.1	6.0	19.8	8.2
NMC 18333 Old Crow Loc. 29	–	29.9	18.3	9.6	18.9	10.8	–	–	7.7	5.6	10.4	6.7	20.5	9.2
NMC 13578 Old Crow Loc. 11A	–	27.9	18.7	9.3	18.0	9.8	–	–	7.4	–	10.1	6.3	18.7	8.5
NMC 18332 Old Crow Loc. 29	–	26.5	–	–	16.9	9.4	–	–	–	–	10.0	6.0	17.5	8.0
NMC 24214 Old Crow Loc. 66	–	29.1	–	9.8	–	10.3	6.6	4.2	8.4	5.3	–	–	19.3	8.5
NMC 13587 Old Crow Loc. 11A	–	31.9	20.5	11.1	20.7	11.7	–	–	–	–	11.7	6.7	21.5	9.4
NMC 13584 Old Crow Loc. 11A	–	29.9	17.9	9.4	18.2e	9.7	–	–	–	–	10.5	6.4	20.1	9.1
NMC 18334 Old Crow Loc. 29	–	–	16.2	8.9	15.9	8.6	5.9	4.0	–	–	9.8	5.4	–	–
NMC 25078 Old Crow Loc. 81	–	28.0	–	–	18.8	9.6	–	–	–	–	9.9	6.2	18.8	8.2
NMC 24661 Old Crow Loc. 22	–	–	–	–	–	–	–	–	–	–	10.4	6.2	–	–
NMC 24903 Old Crow Loc. 11A	–	–	–	–	20.5	10.8	–	–	–	–	–	–	20.8	9.2
NMC 18259 Old Crow Loc. 11A	–	–	–	–	19.3	9.8	–	–	–	–	–	–	19.6	8.5
NMC 20320 Old Crow Loc. 29	–	–	19.3	9.6	–	–	6.8	4.4	7.5	5.3	10.5	6.3	–	–
NMC 20008 Old Crow Loc. 65	–	–	16.2	7.5	–	–	–	–	7.9†	5.1	9.6	5.9	–	–
NMC 18255 Old Crow Loc. 11A	–	–	20.7	9.8	–	–	6.7	4.4	8.3	6.0	10.8	6.9	–	–
Gulo gulo luscus. Recent, Y.T.														
NMC 31773	♂	33.3	19.8	10.2	19.7	10.7	8.2	5.8	11.4	7.6	11.7	7.6	22.4	9.8
NMC 31776	♂	33.2	22.0	10.2	21.7	11.8	6.6	4.6	9.0	5.9	11.9	8.1	22.3	10.3
NMC 33692	♂	33.1	22.9	11.1	21.1	11.6	8.7	5.7	11.7	5.7	11.8	7.8	22.1	10.2
NMC 34311	♂	32.9	21.3	10.7	19.8	10.9	6.5	4.6	8.5	6.0	12.2	8.0	22.0	10.1
NMC 34310	♂	32.6	20.9	8.9	19.8	10.9	6.4	4.4	8.6	5.3	12.1	7.5	21.6	10.2
NMC 31054	♂	32.0	21.5	10.0	20.3	11.0	6.4	4.2	8.3	5.5	11.5	7.6	21.4	9.3
NMC 34312	–	31.6	20.8	9.6	20.2	10.3	5.1	4.0	8.0	5.0	11.4	7.1	20.9	9.2
NMC 34309	♂	31.3	18.6	8.8	17.5	9.8	–	–	7.5	5.3	11.8	6.8	20.7	9.0
NMC 31056	♀	30.5	18.9	8.9	17.6	9.6	5.6	3.6	7.6	4.9	10.8	6.7	20.1	8.5
NMC 31079	♀	30.0	18.2	8.6	17.1	9.8	5.8	4.0	7.5	5.1	10.6	6.5	20.4	8.9
NMC 31775	♀	29.4	19.6	9.4	18.3e	10.2	5.8	4.0	6.8	4.5	11.1	7.0	19.4	9.4
NMC 31055	♀	29.1	18.9	9.4	17.2	9.9	5.4	3.9	7.3	4.9	10.3	6.7	19.8	9.5

* 1 - Alveolar length P_4-M_1.

2 - Mandible depth below centre of P_3.

3 - Mandible width at P_3.

4 - Mandible depth at anterior cusp of M_1.

5 - Mandible width at anterior cusp of M_1.

6 - Length P_2.

7 - Width P_2.

8 - Length P_3.

9 - Width P_3.

10 - Length P_4.

11 - Width P_4.

12 - Length M_1.

13 - Width M_1.

valley gravels, is that the teeth that are preserved (P^2-M^1 on both sides) are solid and ivory white, whereas the cranial bone is a dark, rusty brown and heavily stream-worn and weathered. It may be of very late Wisconsin to Recent age. The following regions of the cranium show damage: central parts of the zygomatic arches are lacking; the edges of the glenoid fossae; bone near the roots of the incisors and canines. Comparative measurements show that NMC 14582 falls within the upper range of Recent *Gulo gulo luscus* from the Yukon, and it probably belongs to that taxon.

NMC 16321 is a small fragment of left maxilla containing a complete LP^4 and the lateral root of LM^1 from Old Crow Locality 65. The bone and teeth are stained chocolate brown and show signs of root impressions. The LP^4 is smaller than most specimens to which it was compared. Two Recent Yukon females (NMC 31056, 31079) have slightly smaller P^4s.

Mandibular fragments, especially those containing P_4 and M_1, are most commonly found. They vary in staining from dark brown to black, the teeth often being darker than the mandibular bone. NMC 20746 from Old Crow Locality 20 is a left mandible with LP_2-LM_1. The anterior

part of the jaw and ascending ramus are lacking. The animal represented was probably an adult when it died, for the tips of the cusps are worn and there is a facet on the lateral surface of M_1, made by the upper carnassial. NMC 24797 from Old Crow Locality 22E is a right mandible fragment containing RP_2-RM_1. Vertical cracks have formed on the lateral surface of the mandible below M_1, on the anterior cusp of M_1 and on the cusp of P_4. NMC 18333 from Old Crow Locality 29 is a right mandibular fragment with RP_3-RM_1, which lacks the anterior part and ascending ramus. The anterior cusps of M_1 are deeply cracked. NMC 24236 from Old Crow Locality 22 is one of the most complete mandibular fragments, but contains only RP_4 and RM_1, and a partial root of RP_2. Part of the symphyseal surface is lacking, as is the superior part of the ascending ramus and the medial part of the condyle. On the lateral surface of M_1 is a facet made by the upper carnassial.

NMC 13578 from Old Crow Locality 11A consists of the central part of the horizontal ramus of the left mandible with LP_3-LM_1, and partial sockets for LC_1-LP_3 and LM_2. The medial surface is paler than the lateral one, and may have been exposed to surface weathering at one time. NMC 13587 from Old Crow Locality 11A is a

left mandible with LP_4-LM_1. It appears to represent an old individual according to the lateral wear facet on M_1 (the central cusp of which apparently was broken in life). An unusual feature of this specimen is that LP_1-LP_4 appear to have been broken off at the roots and healed over flush to the alveolar surface. Enamel on the anterior cusp of M_1 probably cracked off relatively recently. NMC 13584 from Old Crow Locality 11A consists of most of the horizontal ramus of the left mandible with LP_4 and LM_1, and the sockets for LC_1-LP_3 and LM_2. The ramus, particularly the interior surface, shows a large series of horizontal surface cracks. Cusps of the teeth are slightly worn.

NMC 24212 from Old Crow Locality 66 is a right mandibular fragment, the inferior half of which is lacking. LP_2-LM_1 are present. Of these teeth, the anterolateral surface of M_1 and the tip of P_4 may have been broken away during the wolverine's lifetime. NMC 18334 from Old Crow Locality 29 is the anterior part of a right mandible with LP_2 (the roots of which show well above the alveolar margin), LP_4 and the anterior half of LM_1. The small size of the specimen, its fragile, smooth-surfaced bone and two sharp cusps on the teeth indicate that the wolverine represented by the fossil died when it was fairly young. The surface staining of the bone is more reddish than in the other

wolverine fossils. NMC 18332 from Old Crow Locality 29 consists of a fragment of the right mandible containing RP_4-RM_2. M_2s seem to drop out of their sockets readily, and are seldom preserved. Worn tips of cusps on P_4 and M_1 and the pronounced lateral facet on M_1 indicate an adult animal. NMC 25078 from Old Crow Locality 81 is a right mandibular fragment with RP_4 and RM_1. Wear on the cusps and the lateral faceting of M_1 indicate the specimen represents an adult animal.

NMC 20320 from Old Crow Locality 29 is an anterior fragment of a right mandible containing RP_2-RP_4. The cusp on RP_4 is heavily worn, suggesting an old individual. An almost identical fragment, NMC 18255 from Old Crow Locality 11A has heavily worn RP_4 and RP_3, but the tip of RP_2 is only slightly worn. NMC 20008 from Old Crow Locality 65 consists of a left mandibular fragment with LP_3 and LP_4. Its relatively shallow mandible suggests that it is from a wolverine that was relatively small for its age. The cusp of P_3 was probably worn away or broken off during the life of the individual.

NMC 24903 from Old Crow Locality 11A is a small posterior fragment of a left mandible with LM_1. The central cusp is cracked through vertically. Well marked

ridges on the exposed anterior root of M_1 suggest that some idea of the individual ages of Pleistocene wolverines may be obtained by sectioning this root and searching with a microscope for annual layers in the cementum. NMC 18259 from Old Crow Locality 11A is a right mandibular fragment with RM_1. NMC 24661 from Old Crow Locality 22 is a fragment of a left mandible with LP_4 and LM_1. The heavy wear on the occlusal surfaces of the teeth and the pocked appearance of the periodontal bone indicates a very old animal.

Discussion

In the course of comparing the Old Crow mandibles with Recent ones from the Yukon Territory, I was impressed that the teeth of the former were slightly smaller than the latter. To test this idea, I compared means of P_4 and M_1 (most commonly preserved in the fossils) size in the two samples. A specimen of an obviously immature individual (NMC 18334) was omitted from the calculations. Fossil P_4s were 7.9% shorter and 12.3% narrower, while M_1s were 6.2% shorter and 8.5% narrower. On the average, the Old Crow specimens have P_4s and M_1s about 8.7% smaller than Recent Yukon specimens sampled. It is difficult to say what taxonomic importance, if, any, this observed size difference has.

Kurtén (1973, Table 2) gives mean lengths for M_1s of Recent Fennoscandian (20.7 mm), late Pleistocene